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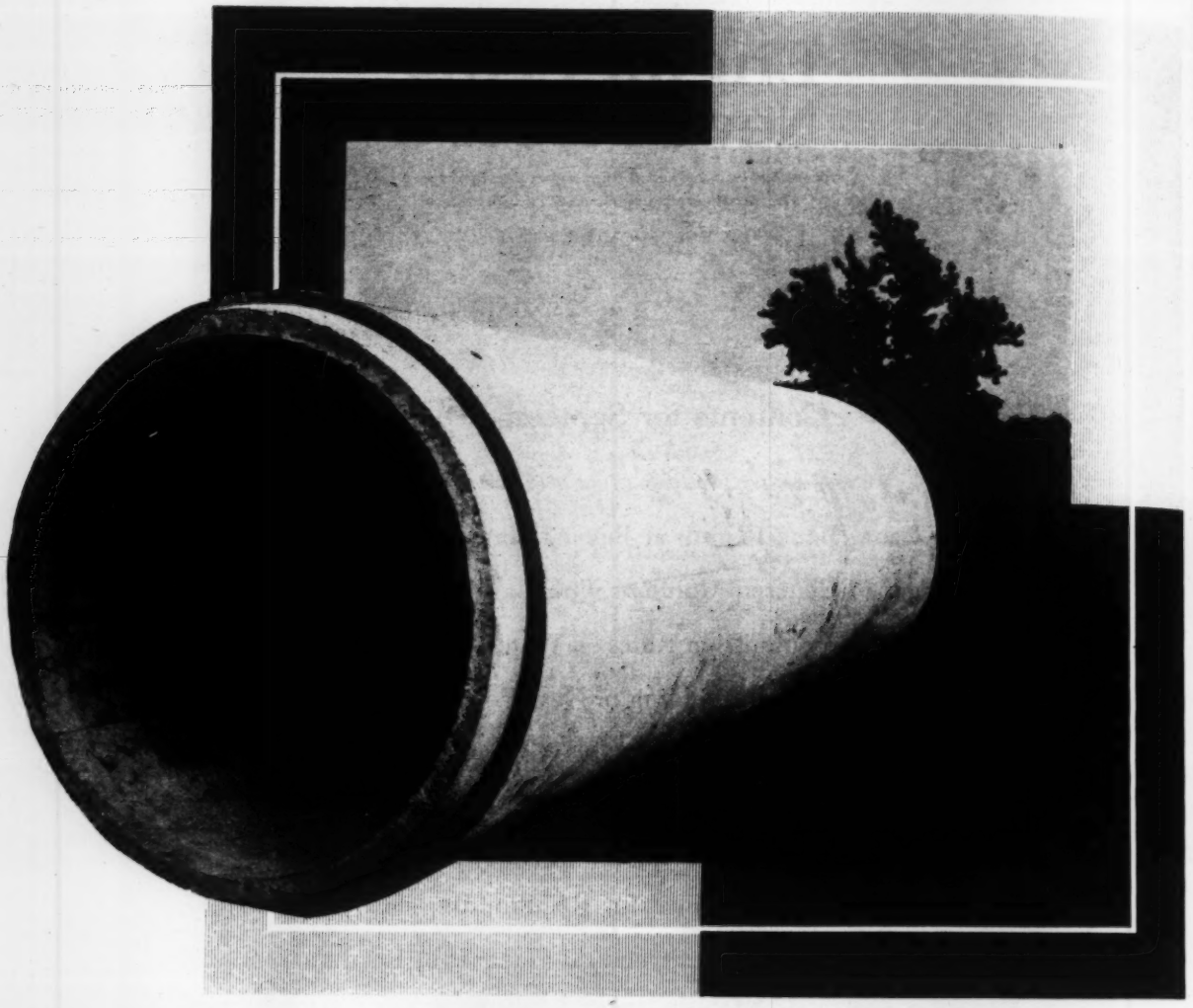

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Machine Places Riprap at Beauharnois

Traveler used in construction of power house is rebuilt for use in placing riprap on part of the banks of 15-mile intake canal of Beauharnois power plant on the St. Lawrence River

By J. A. Knight
Designing Engineer, Beauharnois Construction Co., Beauharnois, Que.

AN UNUSUAL problem in handling riprap for the protection of earth banks against erosion was presented by the intake canal of the Beauharnois power project, now nearing completion on the St. Lawrence River in Quebec, because of the large area needing such protection. The power plant is located on the south shore of Lake St. Louis, with a 15-mile intake canal extending back upstream to Lake St. Francis (*ENR*, Sept. 11, 1930, p. 916). The land crossed by the canal is flat, all of it lying below the level of Lake St. Francis, and hence the entire canal is restrained within embankments built of glacial material excavated in obtaining an adequate depth of channel.

Protection of the banks from wave action presented a riprap undertaking 30 miles in extent. In the preliminary planning it was anticipated that this work could be attacked in a number of different ways, using mechanical methods as much as possible to eliminate costly hand-placing. After all other available methods were applied to the schedule, a considerable distance remained, which seemed to present an opportunity for a machine specially designed to spread riprap over the slope.

By the time the point had been reached in the construction operations where the use of some such machine appeared desirable, a considerable amount of heavy equipment that had been used in the construction of the power house was idle. This equipment included travelers that seemed to have good possibilities. Each traveler was a gantry of 32 ft. 5-in. gage, carrying two derricks with 100-ft. booms, capable when counterbalanced of sup-

Placing rock on the banks of the Beauharnois canal with a machine made from a construction traveler.

porting loads of 8,000 lb. at 100-ft. radius on each derrick in any position. The gantry was 40 ft. long and had a clearance above rail of 18 ft. 6 in.

The general scheme used in converting one of these gantries into a riprap-placing machine was to install a skip between the legs at ground level, into which rock could be dumped directly from air-dump cars, and to arrange the skip so that it would discharge into an elevated hopper from which the rock would pass to a pan conveyor and thence to a belt conveyor suspended on a boom paralleling the slope of the dike. Details of the arrangement are shown in the accompanying drawing.

In order that rock could be handled through the hoppers to the pan conveyor and then to the belt conveyor, it was necessary to eliminate extremely large blocks; therefore it was proposed to pass the material through a 48x60-in. jaw crusher of a capacity of 230 tons per hour. This same capacity was taken as the design capacity of the machine. Since the material was to be delivered to the machine in 20-yd. side-dump cars, the skip had of necessity to be sufficiently large to contain one entire carload of rock. By passing the material through the crusher the maximum size was reduced to between 12 and 14 in.

In order to get sufficient chute clearance from the hopper to the belt, if the hopper was to discharge directly to the belt, it would have been necessary to raise the hopper considerably above the deck of the traveler. This was not desirable, so the hopper was placed below the floor level, and a pan conveyor was installed below the hopper.

Description of machine

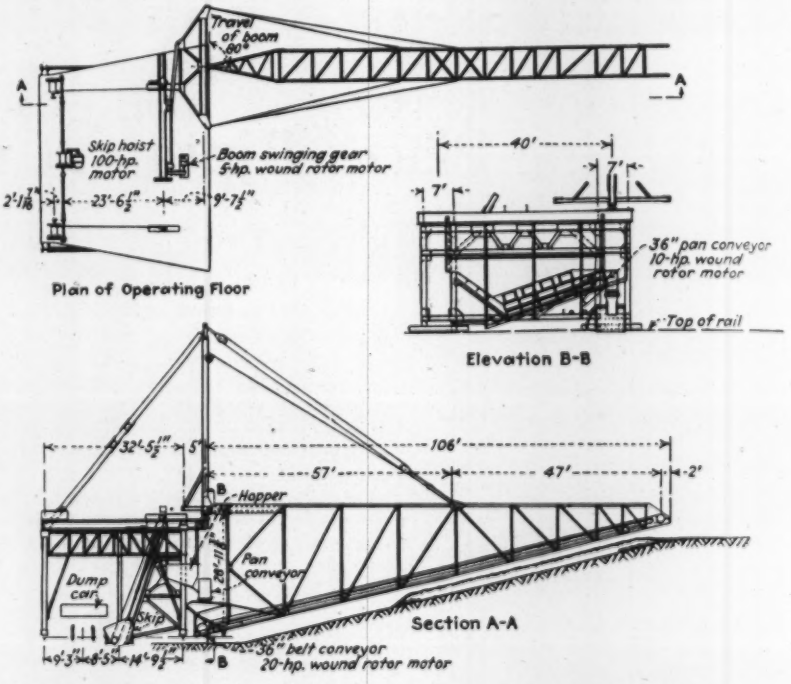
The machine as built consists of an operating floor about 26 ft. above the top of rail and about 40 ft. square. The floor is of steel-frame construction with wood covering supported by six steel columns, four on the side closest to the dike and two on the opposite side. Cross-trusses provide lateral stiffness.

The columns frame into trucks mounted on cast-steel double-flanged wheels. The back legs are connected by latticed bracing and by a deep steel box for holding the counterweight to balance the overhanging boom and conveyor. On the floor is mounted the skip hoist and motor and also the boom-swinging gear.

On the forward corner of the floor, toward the dike, one derrick mast is erected with stiff-legs connected to the floor framing. This mast is cantilevered over the supporting columns a sufficient distance to allow the free swinging of the inner end of the belt conveyor, which is supported on a 100-ft. bridge-type boom suspended from the top of the mast and pivoted above the deck line. This allows a free horizontal swing of the boom of about 87 deg.; that is, from a position almost in line with the direction of travel to a position at right angles to that direction. The boom-swinging mechanism consists of a long acme-threaded screw driven by a motor through a series of gears. This screw passes through a brass nut in a cross-head, which is linked to a modified bull-wheel by a connecting rod. A limit switch at either end of the cross-head guide reverses the travel of the cross-head. The mechanism is designed to operate the boom against a wind pressure of 30 lb., per sq.ft. of exposed surface.

The skip, which was fabricated from 1-in. steel plate, is 30 ft. long and has to be hoisted from both ends. To prevent jamming due to uneven lifting, one drum of the 100-hp. three-drum hoist was removed, and an extension shaft was substituted on both sides. On the outer ends of this shaft were mounted two drums driven through flexible couplings. In this way both ends of the skip are hoisted on one shaft. In hoisting, the skip rises in leads, making an incline of about 15 deg. to the vertical and is so guided by rollers that it trips automatically at the top of its cycle. The hopper is of steel-plate construction, hung from the steel of the floor, and in itself forms part of the swaybracing of the front panel of the machine. Stone is discharged from this hopper to a 36-in. manganese steel-pan conveyor set at an angle of 21 deg., driven by a 10-hp. motor, which delivers the rock through a circular hopper to the 36-in. belt conveyor on the boom. The supply of rock from the hopper is controlled by swinging doors, which are counterweighted to pinch the rock in the bottom of the bin. These gates, of which there are four, can be manually controlled from a walkway outside the pan conveyor. The 30-in. belt is driven by a 20-hp. motor mounted at its lower end. The supports for the belt and the driving mechanism are all incorporated in the framing of the boom, which is 106 ft. long over all.

The first operations for which the traveler was used did not require frequent moving, and it was therefore designed and rigged so that when moves were required they could be made with a construction locomotive. For this work, however, greater mobility is required. Since the weight of the machine is 560,000 lb. and it will be operated during low temperatures with the attendant resistance due to freezing, with very frequent moves, powerful and flexible motive power had to be provided. For that purpose two large 100-hp. hoists have been mounted back to back on a standard railroad flatcar, with one hoist connected by two five-part lines to the body of the machine and the other snubbed to deadmen that can be attached to the rails ahead of the car. By the use of these two hoists the pulling car can be drawn ahead and snubbed, then the other hoist can be used with the multiple-part lines to draw the riprap machine forward. This gives a very elastic control of the movement of the machine. In practice it has been found that it can be drawn forward so slowly that cars of rock can be dumped into the skip while the entire machine is moving.



Details of the changes made in converting a traveling hoist into a riprap-placing machine.

The operation of the machine is controlled by a signal man on the dike. Grade stakes are installed by the field engineers in advance of the machine, and by a combination of swinging the boom and advancing the machine a uniform layer of rock is deposited over the required surface. As the belt runs at a uniform speed, and as the boom-swinging gear and the pulling car can both have variable speed and are controlled by visual signals from the operator on the bank, holes or other irregularities can be filled up simply by varying the speed of swing.

The capacity of the machine as designed was estimated to be seven cars per hour; in practice it was found that a five-car train could be handled in about 20 min. The only operating difficulty that has been encountered was the obtaining of a sufficiently solid roadbed ahead of the machine.

The general ideas for the conversion of the traveler to a riprap machine were proposed by the vice-president and general manager of the Beauharnois Construction Co., F. H. Cothran, and the design was worked out by the Dominion Bridge Co. and the writer.

Concrete Columns with Large Bars Offer Advantages

Columns with a high percentage of 2-in. bars save material, floor area and cost over columns designed under codes limiting steel percentage to 6 and bar sizes to 1¼ in.

By Thor Germundsson
Formerly Designing Engineer, Chicago Subway Commission

A NOVEL TYPE of reinforced-concrete column with vertical bars as large as 2 in. square, butt-welded at the splices, was used in a thirteen-story building erected for Rockford Newspapers, Inc., Rockford, Ill., during 1931. The columns were designed conservatively, using only 8 per cent of reinforcing because the method of welding vertical bars was being put to a practical test for the first time. This article is a discussion of the design of columns of this type, with steel percentage as high as 12.7, using the Rockford building as an illustration of their practicability.

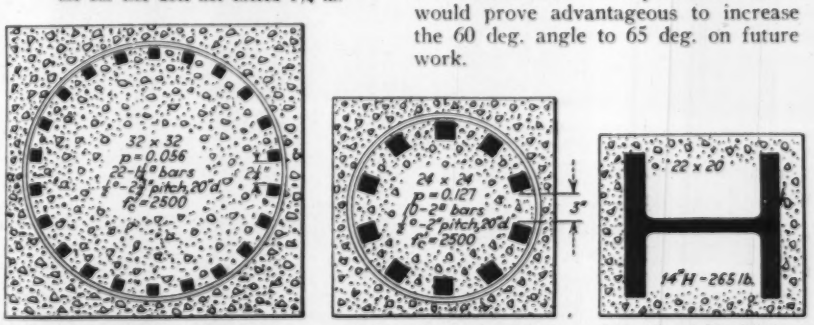
Advantages of larger bars

Modern design codes specify that not more than 6 per cent of vertical bars shall be used in concrete columns with longitudinal and spiral reinforcement. This limitation has been adopted because it is difficult to place more than 6 per cent of 1½-in. bars within the spiral, and the 1¼-in. size has been arbitrarily fixed as the maximum. However, larger bars are often needed (1½-in. square bars were specified for the construction of the Wacker Drive in Chicago), and the usual bar sizes could readily and advantageously be augmented by 1½-, 1¾-, 2-in. and even larger square bars. Fig. 1 illustrates the remarkable difference between two reinforced-concrete columns designed to carry the same safe load of about 1,150,000 lb. The first column, following usual design practice, has 5.6 per cent of 1¼-in. bars, and the second represents the new design, with 12.7 per cent of 2-in. bars. Both of these may be compared with the incased structural-steel column. The superiority of the column section with a high percentage of large bars is striking. Size and cost of material, even the tonnage of the reinforcement, are reduced, while the clearance between the vertical bars is ample for concrete placement.

The 2-in. bars used in the Rockford building were plain because deformed bars were not available. Plain bars are satisfactory if two of the top spiral turns are welded to them to aid in transmitting floor loads into the vertical steel.

Among other advantages, the large welded bars, arranged in straight unbroken vertical lines, may be set with an unusual degree of accuracy and neatness, thus facilitating the setting of beam and girder reinforcement. The amount of honeycomb in the shell outside the spiral will be reduced, since the bars are accurately placed and the clearance between them is increased. The advantage of improved concrete protection and less patching is especially obvious in columns with exposed surfaces.

Fig. 1—Comparison of columns having about the same load capacity shows that by the use of 2-in. square bars the column size compares favorably with a structural steel column incased in concrete and is much smaller than the reinforced-concrete column designed under common codes. At the same time the steel tonnage in the large-bar column is less than in columns in which the bar size does not exceed 1¼ in.



Usual Type of Concrete Column Safe Load: 1,170,000 lb.

Large-Bar Concrete Column Safe Load: 1,150,000 lb.

Structural Steel Column Safe Load: 1,170,000 lb.

Column design

Curves based upon different column-design formulas are plotted in Fig. 2. The solid-line curves follow the American Concrete Institute's building regulations, 1928, Sec. 1103. These curves are not intended for columns with more than 6 per cent of bars. The dotted line illustrates the formula proposed by F. R. McMillan in his "Study of Column Test Data," *Proceedings*, American Concrete Institute, Vol. 17, 1921. McMillan's formula, which was used for the Rockford building, agrees very closely with the A.C.I. formula for $f'_c = 2000$ and is extended to $p = 0.08$. For high percentages of reinforcement, however, a new design formula probably is necessary. Some of the data obtained from the recent concrete-column tests at the University of Illinois and Lehigh University may be used for this purpose, and the author has plotted in Fig. 2 curves of a formula that he believes useful and theoretically sound. A brief summary of the basis upon which this formula is founded is given in the caption of Fig. 2.

Butt-welded splices

Bars as large as 2 in. square require too long overlaps and should therefore be butt-welded at the splices. The type of weld used in the Rockford building is shown in Fig. 3. The bars were cut in the shop at an angle of 30 deg., and the apex of the 60 deg. angle was ground. In the field this edge was placed on the side toward the center of the column in order to make the weld accessible.

The process of welding progressed without difficulty. There was some objection, however, to the large volume of weld metal to be deposited in the angle between the upper and lower bars. For this reason it is probable that it would prove advantageous to increase the 60 deg. angle to 65 deg. on future work.

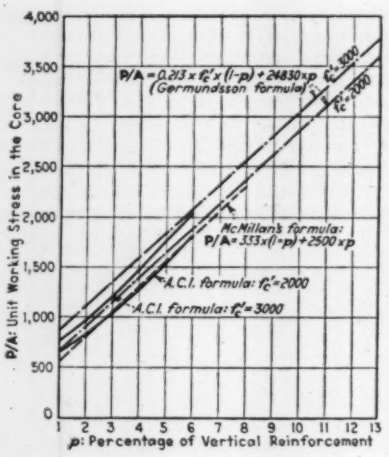

P/A = 0.213 x f'c x (1-p) + 24830 x p (Germundsson formula)
f'c = 4000
f'c = 3000
McMillan's formula: P/A = 333 x (1-p) + 2500 x p
A.C.I. formula: f'c = 2000
A.C.I. formula: f'c = 3000
P/A: Unit Working Stress in the Core
p: Percentage of Vertical Reinforcement
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13

Fig. 2—Comparison of standard concrete-column formulas with one suggested by the author. McMillan's formula was used in the design of the Rockford building. The author's formula is based upon facts brought out in the recent concrete-column investigations at the University of Illinois and Lehigh University, in which the ultimate strength was expressed by the formula $U/A = 0.85\ f'_c\ (1-p) + pf_y + 28{,}000\ p_s$. The authors' safe-load formula is obtained by dividing the first term (applicable to the concrete) by a factor of safety of 4, dividing the last two terms (applicable to the reinforcing steel) by 2 and substituting 45,000 for f_y, the yield point strength of the vertical bars, and $p/6$ for p_s.

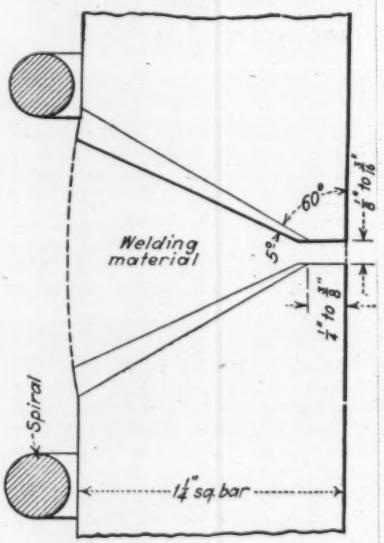
The erection plan followed in the Rockford building proved to be practicable and satisfactory. A schematic erection diagram is shown in Fig. 4. Clamps are attached to each of the bar stubs extending, from the column below above the rough surface of the floor, and a braced center post is erected and aligned. Templet *A* is attached to the center post about 6 ft. above the floor, and the vertical bars are set and tied to it for welding. A variation of this plan was followed in the Rockford building, where the center post was omitted and the templet was tied to one bar after it was braced and welded.

After the joints were welded the braces and templet were removed for re-use on the next column. The column, beam and slab forms were then erected, the spiral slipped over the verticals, and templet *B* was placed and tied to the column bars about 6 in. below their top in order to fix their position during the casting of the concrete.

If it is practicable to erect the bars in lengths corresponding to two stories, the welds may be staggered, only one-half of the bars being welded at each floor. In this case, templet *A* may be tied to the longer bars, thereby eliminating the center post.

The connection of the large column verticals at the top of the footing may be made either by welding the bars to dowels extending into the footings or by welding to rolled-steel plates. The first method was used in Rockford.

Fig. 3—Welded joint between vertical bars as used in the Rockford building. By increasing the 60-deg. angle to 65 deg. the amount of weld metal could be reduced without impairing the efficiency of the joint.



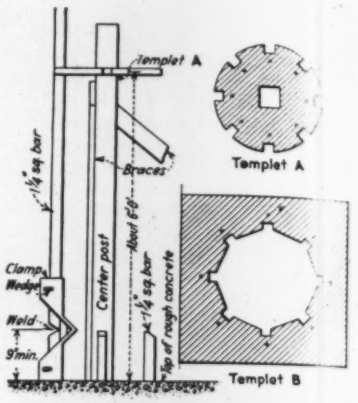


Fig. 4—Erecting large vertical bars in the Rockford building required some special equipment to hold the bars in position while they were being welded.

Since it requires care to place the dowels accurately, and since it is often difficult to provide sufficient length of embedment, the base-plate construction may, however, be preferable.

Cost

The cost per linear foot of column is itemized in the accompanying table for the three sections shown in Fig. 1, all of which have the same safe-load capacity. The cost of welding is as yet rather an uncertain item. It seems reasonably conservative, however, to estimate that it will take one man 2½ hours to weld ten 2-in. bars, at $2.50 per hour. The cost of welding the column shown in the table is then about 50c. per linear foot of column when the story height is 12 ft. The cost of welding the bars in the Rockford building was about twice this figure, but it included the cost of setting the bars, which is ordinarily done by steel setters. Allowance should also be made for unusually high labor cost on a pioneering job.

According to the table, the cost of the column with the large bars is $1.07 less per linear foot than the cost of the usual concrete column, and $3.25 less than the cost of the structural-steel column incased in concrete. Some of the cost items have not been included because they cannot be estimated in general. The cost of finishing the surface of the smaller concrete column is about 25 per cent less than for the larger column, and the rentable floor area is increased by 3.1 sq.ft.

ESTIMATED COST PER LINEAR FOOT OF COLUMNS OF DIFFERENT DESIGNS

		Quantity	Unit Cost	Cost
p = 0.127, (Fig. 1), 24×24				
Vertical bars	137.2	137.2 lb.	0.04	$5.49
Spiral	22.5×11/12	20.6 lb.	0.06	1.24
Concrete	2.00×2.00	4.0 ft.	0.30	1.20
Forms	2.00×4	8.0 ft.	0.15	1.20
Total, excluding cost of welding				$9.13
Cost of welding (see text)				0.50
Total				$9.63
p = 0.056, (Fig. 1), 32×32				
Vertical bars	117.7×14.5/12	142.3 lb.	0.04	5.69
Spiral	23.1×11/12	21.2 lb.	0.06	1.28
Concrete	2.67×2.67	7.1 ft.	0.30	2.13
Forms	2.67×4	10.7 ft.	0.15	1.60
Total				$10.70
Cost of welded column				9.63
Excess over cost of welded column				$1.07
Structural-steel column, 22×20 (Fig. 1)				
Structural steel	265×1.05	273.0 lb.	0.04	10.93
Concrete	1.83×1.67	3.0 ft.	0.30	0.90
Forms	(1.83+1.67)×2	7.0 ft.	0.15	1.05
Total				$12.88
Cost of welded column				9.63
Excess over cost of welded column				$3.25

Town 100 Per Cent Paved

Silver Springs, N. Y., soon will have no unpaved streets. A contract has recently been awarded for the paving of the remainder of the dirt roads in the village. At an election held last March the village voted to bond itself for $25,000 to pave all the remaining roads within its boundaries.

Power Commission Makes Ruling on Allowable Water-Power Costs

Actual cash outlay closely adhered to—Capitalization of earning power of a franchise forbidden—Fee of subsidiary in excess of expenditures eliminated

THE Federal Power Commission, on July 29, made public its first finding of what constitutes the "actual legitimate original cost" of a water-power project under the federal water-power act of 1920. The project in question was Mitchell Dam of the Alabama Power Co., built under a license issued June 27, 1921. Construction was carried out under a cost-plus contract made between the power company and its wholly owned subsidiary, the Dixie Construction Co. The commission's finding was based upon section 4(a) of the water-power act, which provides that "in order to aid the commission in determining the net investment of licensee in any project, the licensee shall file with the commission a statement showing the actual, original cost of construction of such project."

Under this section of the act the power company filed a statement of the cost of the project, which has been reviewed by the commission's accounting staff. Most of the items relating directly to construction cost were accepted, others were adjusted by mutual agreement, and the remaining items that could not be settled by agreement between the company's officials and the commission's staff were submitted to the commission for its final determination. These items were the subject of the commission's findings made public on July 29. As indicative of the attitude the commission will take on other projects throughout the country, its findings are of wide interest. They were summarized briefly in our news pages Aug. 4, p. 144. Fuller abstracts are given below.

Cost of the project

The Alabama Power Co.'s statement gave the cost of the project up to the end of 1925 as $10,646,056. Out of this amount the accounting division passed $5,634,117. The principal items remaining in question were as follows:

Land, water rights and franchises	$3,500,000
General administration, Alabama Power Co.	171,028
Dixie Construction Co. profit	183,540
Electric energy used during construction	72,788
Interest during construction	672,342

The total of all the items finally allowed by the commission was $6,173,576, plus an item of interest during construction yet to be determined.

Land and franchises

The amount of $3,500,000 set down as the cost of land, water rights and franchises used for the Mitchell Dam project, which licensee claimed to have acquired in 1913 through the consolidation of five pre-existing companies, represented half of the par value of 72,000 shares of new stock which were exchanged at that time for the old stock of the Alabama Power Co. In support of its claim the power company urged that the commission was bound by the valuation of assets agreed upon by the directors of the five companies at the time of the merger, since they were contemporaneously familiar with the facts and must be presumed to have exercised a fair amount of judgment; also that since the stock was not bought and sold on the public market, it had no ascertainable market value; and since Alabama laws prohibit the issuance of stock except for money, labor done or property actually received, the par value of this stock must be presumed to be its actual value in the absence of evidence to the contrary.

The commission rejected this method of determining cost and allowed only the actual cash outlay for land and franchises involved in the Mitchell Dam project, where they could be obtained in the records of the original companies entering into the merger, or a value determined by comparison with the value of adjoining lands where such original costs could not be determined. The net result was to reduce the item for land, franchises, etc., from $3,500,000 to $76,135.

In further support of its land values the power company produced computations by engineering experts as to the value of the land in question when used in a comprehensive water-power development, compared with the cost of producing the same power by steam generation. These figures were rejected by the commission as inadmissible as evidence of the cost of the land, as they related to earnings expected from the development and not to the cost of assembling the land. "To compute costs in terms of earnings," said the commission, "involves a contradictory use of terms. Earnings are the difference between revenue and costs, and to magnify costs as a reflection of earnings is but to destroy the very earnings upon which the costs have been based."

Speaking on this point, Chairman Smith, in a concurring opinion, said, "In determining the respective equities of the licensee and the consuming public, the essential premise is that the licensee shall obtain a proper and fair return on his capital investment and no more. This principle of measuring the investment by the actual original cost legitimately incurred was embodied in the federal water-power act. Thus certain intangibles are not capitalized even though they deserve to be taken into account. Such elements are the financial risk involved in the venture, the creative skill in planning the project and the engineering efficiency in its operation. All these are necessarily to be considered, yet they are not elements that can properly be capitalized. Rather, they are considerations which should enter into the determination of the proper rates of return."

Dixie Construction Co. fees

An item of $183,540 as a fee for the Dixie Construction Co., representing a 3 per cent profit computed upon the direct and overhead costs of the company on the Mitchell project, was rejected in its entirety.

At the start of construction the Dixie Construction Co. was a wholly owned and controlled subsidiary of the Alabama Power Co. Shortly after construction was begun ownership was transferred to the Winona Coal Co., a wholly owned subsidiary of the Alabama Traction, Light & Power Co., Ltd., which company held all the common stock of the Alabama Power Co. and a majority of its voting power. The Dixie Co. officers and directors also were officers and directors of the Alabama Power Co.

In its rejection of the fee the commission said, "There is no question that, if licensee had itself constructed this project, it could have claimed no profit upon its costs as a part of its fixed capital structure. Upon the facts before us we cannot view the Dixie Co. otherwise than as in substance a department of licensee's own business, maintained during the construction of this and other of its public utility projects with a view to obtaining emoluments and profits not otherwise allowable under the law. The business advantages urged by the licensee in its brief for the maintenance of the Dixie Co. as a separate corporation are not convincing. All of them would be equally applicable to a construction department of the licensee's own corporate organization. To grant otherwise is to concede a degree of impotency in the management of corporate business that is contrary to common knowledge."

Chairman Smith in his concurring opinion, had this to say as to the Dixie Construction Co.'s fee, "Even though the construction company may have been organized with no intent to defraud, the later contract entered into by officials common to both companies prompts inquiry as to purpose and motive. The evident and admitted affiliation, if not identity, of the makers of this alleged two-party contract surely places upon them the burden of proof as to the propriety of any payment of

profits. The inclusion in the contract of provision for a fee representing a profit obviously had a purpose which finds its ultimate accomplishment in an addition of 3 per cent of the construction costs of the Mitchell Dam—and for what advantage to the parties in interest?

"In the present case no direct personal gain to the officers was implied, yet the effect of the allowance of the fee would be a charge to the capital account of the Alabama Co., carrying an annual interest charge which would have to be met by increasing rates."

Power for construction

The power company charged to the Mitchell Dam project an amount of $72,078 for power supplied from its own system during construction, the charge being computed at commercial rates. The commission allowed only the actual out-of-pocket cost of $30,660 and rejected the company's claim that the commercial rate should be included because it was not permitted by law to sell power at less than the commercial rate. On this point it said, "We find nothing in the construction contract requiring this sale to the contractor before its use on the job, nor any reason for so handling it if it entailed greater cost to the project. While we do not attempt to prescribe methods for the conduct of the licensee's business, we are compelled to disregard excessive expenditures where it appears that the same results could, in the exercise of proper business prudence, have been obtained at less cost."

Of the other major items in question, that of $171,028 for general administration was accepted by the commission. It was lower than the company's first charge based on the estimates of its officers as to amount of time devoted to the project. The accepted amount represents 3 per cent on the total construction cost. What part of the item of $672,342 for interest during construction is to be allowed was not determined. It has yet to be worked out from a detailed study of the power company's records, following agreement upon rates and methods between the commission's staff and that of the power company.

Jack-Frame Underpinning Offers Advantages

System employed on recent New York subway work eliminates initial soil disturbance below footings and gives quick transfer of load and rigid tying together of isolated piers

By John L. Washbourne
Hart and Early Company, Inc., New York, N. Y.

SUBWAY construction in New York has called into use many practices in underpinning existing buildings. The many types, heights and weights of buildings, the many kinds of materials on which they are founded, the variety of types of foundations and the depths to which these foundations are undercut have called both for variety of selection of existing methods and ingenuity in devising new methods. The following article describes a system of underpinning devised particularly for carrying walls and separate columns on footings. It has been widely used by its creators on deep subway construction in New York. —EDITOR.

IN UNDERPINNING a group of buildings, with foundations of isolated piers and footings with various spacings, along a section of New York's third subway system, a departure from the usual methods was used. The same design, method and equipment were used to economic advantage on each building. A typical example is given by Fig. 1.

A list of the governing conditions applicable to this particular job is as follows:

1. The proposed depth of subway excavation alongside the buildings was about 51 ft.

2. The soil strata varied from coarse sand at a depth of 20 ft. to a very fine sand at 40 ft. From this depth to subgrade the usual Manhattan quicksand was encountered, interspersed every few feet with a thick layer of impervious laminated clay.

3. Groundwater was found 15 to 19 ft. below the street surface.

4. All underpinning had to be permanent and within the building lines.

The general design consisted of a cradle for each line of piers to be underpinned between parallel grillage beams, which were supported by piles sunk between them to below the subgrade in the subway and offset from the sides of the piers involved. The beams, pile caps and pier footings were then incased in concrete. The size and number of piles and grillage beams depended upon the pier loads. The method and advantages of sinking the piles offset from the supported piers is of main interest.

Procedure

A pair of grillage beams (standard section) was notched, wedged and grouted into each line of piers to full-flange bearing, one beam on each side of the piers, as shown in Fig. 1. These beams were placed as low as possible and yet were above the top of the footings. If for some reason a full-flange bearing on each pier could not be obtained, two small cross-beams were keyed into the faces of the piers normal to the grillage to deliver the pier load to the grillage. Adequate tierods were placed between each pair of beams.

A jacking frame was then set in place over the proposed center line of the first pile to be jacked down. As shown by Fig. 2, the frame consists of four eye-bar legs made up from two ½x4-in. strap-irons with a 1-in. spacer between. Attached to the lower end of each leg by means of 1¼-in. bolts are two 1x4x12-in. foot plates on edge, which rest on the top flanges of the grillage beams. Between each pair of foot plates are inserted two 1-in. cold-rolled steel bolts, one on each side of the grillage beams. These are caught underneath the beam by a pair of toe plates on edge, very similar to the foot plates above them. The head consists of two 1x12x24-in. plates on edge, each end of the plates attached to the clevis in the upper ends of the legs by means of a 1⅜-in. steel tunnel bolt. Underslung from these two plates is the 2-in. jack plate.

The starting section of pile pipe, one without a sleeve and generally about 8 ft. long, was centered in the frame, and an iron plate was placed on top of the pile. A 60-ton hydraulic ram was inserted between the top plate and the jacking plate of the frame. The ram was connected to an electrically driven, double-acting, hydraulic pump by copper tubing. A pressure gage and a push-button device for controlling the pump were situated alongside in easy access for the operator.

Jetting operations

In the soil encountered the starting piece could be jacked down about 6 ft. without much resistance being recorded on the pressure gage. Another section of pile pipe was added, and a water jet connected to a 1½-in. rubber hose was inserted into the pile sections through a small gouge in the top plate. In order that the elevation of the jet point would always be 12 to 24 in. above the bottom of the pile, a mark was placed on the hose a distance from the point equal to the total length of pile in place less the required 12 or 24 in. The object of this was to keep a constant soil seal and to prevent any scouring action brought on by the jet falling below the bottom of the pile. A water pressure of about 30 lb. per sq.in. was used in the jetting operations. The water and soil were removed by a suction line placed within the pile. The inward flow of water was regulated so that it equaled the outward flow, thus establishing a constant head of water within the pile.

To have each section of pile absolutely plumb, it was laterally stayed from the frame and grillage beams by means of wedges. The operator of the pile frame

tested each section for square ends, a watertight sleeve joint and a true cylindrical shape upon setting it into the frame.

Upon reaching the required subgrade the jet was withdrawn, the pile sounded for length, and a concrete seal was immediately placed on top of the muck seal. This concrete seal was lowered into the pile through the water by a small bottom-dumping concrete bucket made out of a piece of 8-in. pipe. Although the amount of seal was varied according to soil conditions, an average of ½ cu.yd. of stiff concrete was used to each seal. This seal was allowed to set from 24 to 48 hours.

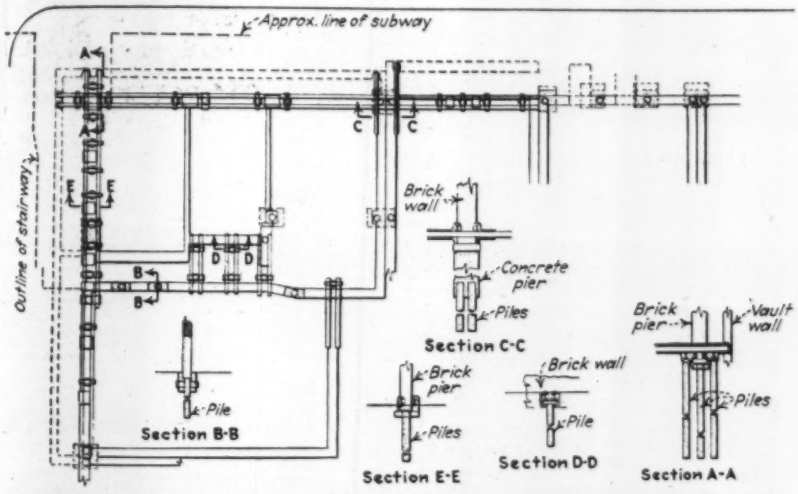
When the seal had set, the pile was pumped dry by a small submersible pneumatic pump, which was lowered into the pile. This pump operated successfully under a 56-ft. head. The air was led to the pump through a small hose and the water discharged through the larger hose. Without this pump the pile operations would have been slowed up materially, as the great majority of the pile subgrades was below vacuum limits, thus necessitating a slow process of bailing.

Immediately after pumping, the pile was inspected and concreted. Concrete of a dry 1:2:4 mix was used. The pile was concreted flush to the top, and the permanent pile plate was placed. The pile was then tested for a 50 per cent overload.

To transfer the load, 1⅛x8-in. cold-rolled steel bolts were stood on end, head up, under the grillage beams from the pile-cap beam. Square-cut washers were used for fillers underneath the nut. These bolts, acting as jack columns, were tightened one at a time on each side by special large spud wrenches. The load was gradually transferred from the original footing to the pile through these bolts. The bolts have been tested successfully to a 48-ton load, receiving it without damage to the threads or nut. It was on the basis of 30 tons per bolt that the number of bolts was assigned to each end of the pile-cap beam. In order to keep an even balance, an even number of bolts was assigned to each end of the pile-cap beam. The bolts have an ultimate strength of 110,000 lb. per sq.in. and a yield point of 85,000 lb. per sq.in. When the load had been taken up, the pile-cap beam was concreted immediately from 12 in. below the top of the pile to the bottom of the grillage beams.

It was the duty of the frame man to operate the hydraulic pump by a push-button device kept near at hand, to keep the pile sections plumb and work the water jet. Care was taken to keep the jet moving at all times, so that it would never be concentrated at any point at the foot of the pile. This kept the top of the muck seal fairly level and turbulated the sand so that it would stay in suspension until it was carried outside the pile by the water. As the pile was jetted and jacked, a constant pressure of 2,500 to 3,000 lb. per sq.in. (20-24 tons) was maintained to keep it moving through the sand. Upon striking the fine sand the pressure, in order to maintain the same speed of movement, would rise to about 4,000 lb. per sq.in., or 32 tons. When the hard clay was struck the pressure immediately rose to 6,000 and 7,500 lb. per sq.in., or 48-60 tons, and the progress of the pile was slowed up. In some cases this clay proved to be so impenetrable that two rams were necessary to give a jacking load of 70 tons. Progress in these cases was only 2 to 3 in. at a time. The maximum allowable pressure (governed by the reaction and the strength of the pile and sleeves) was then held while the jet was driven slightly into the clay in an effort to reduce its resisting force. Where the computed pile subgrade fell inside this clay strata the piles were generally driven to the fine sand below to grain bearing. As soon as the pile foot had broken through this clay seam into the fine sand, the pressure would drop back, and the speed of the movement would increase to that recorded for the similar sand below the clay strata. This reversion was noted in jacking all piles that pierced the clay.

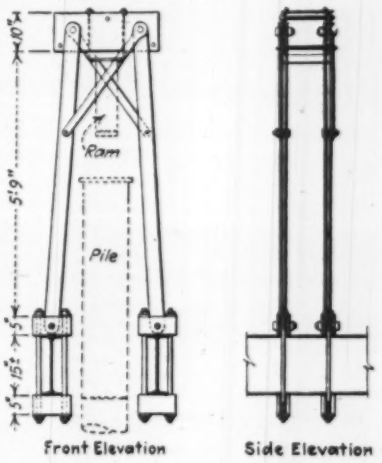
Fig. 1—Typical foundation underpinning, showing various methods of applying grillage beams and piles to wall and column footings.



Advantages of method

1. Each underpinning member can be tested to more than its known required load. The grillage beams and pile-cap beams are tested during the pile test as well as the pile test itself. The necessity for relying on dry packing or grouting, as in the cases where a column or wall is picked up on a concreted pit, is done away with. By having the pile offset from the pier, a test of an overload can be made, as the additional reaction may be borrowed temporarily from the adjoining pier through the grillage beams.

Fig. 2—Frame for jacking down pipe-pile sections in underpinning operations.



2. By the use of steel bolts the pier load is transferred from its original footing to the new footing. An ordinary pair of steel wedges ½x12 in. will raise about 12 tons when driven under conditions usual to underpinning. One special steel bolt, 1⅛x8 in., will raise 30 tons by means of a large spud wrench under the same conditions. The cost of one bolt is slightly less than that of a pair of wedges.

3. The soil underneath the existing pier footings is never disturbed. This practically eliminates initial settlement.

4. The jacking and pile-mucking operations are done wholly from the cellar floor or the open space around the base of the footing.

5. When the pier load calls for two or more piles, these piles are separated and on opposite sides of the pier. In this way the theoretical stress lines set up in the soil by the load from the foot of each pile cannot intersect.

6. A building underpinned in this manner is securely tied together as a unit by the longitudinal grillage beams concreted and interlocked into every building pier affected, thus decreasing lateral movement.

Model Study of an Arch Bridge for Statically Indeterminate Stresses

Novel design for Main Ave. bridge in Cleveland is analyzed by strain measurements on celluloid model

By Fred L. Plummer

Associate Professor of Structural Engineering, Case School of Applied Science, Cleveland, Ohio

ANALYSIS of statically indeterminate stresses in the central arch of the proposed Main Ave. bridge over the Cuyahoga River in Cleveland was recently carried out by direct measurement of strains on a celluloid model. The method proved sensitive and effective. It has also been found valuable in the design of windbracing for slender towers and for heavy irregular machinery frames, problems that have been studied in the models laboratory of Case School by various methods, including the use of deformeters, polarized light, brittle materials, tensometers and other devices.

Main Ave. bridge is a proposed $6,000,000 county bridge in the heart of Cleveland, near the mouth of the river. The design, prepared by Wilbur Watson & Associates, involves a half-through central arch of 270-ft. span and 148-ft. rise, and smaller side-span arches of deck type. The central arch is distinguished not only by its high rise and its parabolic form but also by the fact that it has no lateral bracing except for a 50-ft. length at the crown, and depends largely on the rigidity of the arch ribs themselves for its lateral stiffness. As important secondary stresses were therefore to be expected, and as their highly indeterminate nature made algebraic analysis difficult and uncertain, the model analysis was undertaken.

Each of the two ribs, which are spaced 71 ft. 9 in. c. to c., consists of two plate-girder members 7 ft. 3 in. apart, connected by strong crossbracing top and bottom and by diaphragms at 6-ft. intervals. Since the ribs are on the line of the footwalks, the walks pass through the ribs where the deck, 85 ft. above the arch pins, intersects the arches, and the rib bracing is necessarily interrupted at these points. Here, also, the ribs transfer most of their lateral load to the deck—a concrete slab on stringers carried by floor beams spaced about 15 ft. apart. High secondary stresses were to be expected in the ribs near the deck intersections. It was believed that if an exact small-scale model of the bridge were built of a suitable material and the strains in this model were measured under load, the stresses could be determined more accurately than by any other method. This belief was fully justified by the results obtained.

The model, on a 1:36 scale, was built of celluloid, a material available in sheets of almost any thickness, singularly uniform in quality. Specimens from sheets of different thicknesses showed not more than 1 per cent variation in modulus of elasticity. The material is easily cut or sawed and may be joined by a special glue that produces welds equal in strength to the original material.

All sections of the steel structure were reduced to equivalent sections in the model. A loading frame was constructed alongside, through which weights working over small pulleys could apply horizontal loads to any part of the model. If equal loads are applied in the same manner to two exactly similar structures built to scale ratio n, the resulting unit stresses will be in the proportion of $1:n^2$, provided the stresses in each structure remain within the elastic limit of the material with which that structure is constructed. The larger stress will of course exist in the smaller structure. Under the same conditions the unit strains will be in the proportion of $1:n^2m$, where m is the ratio of the moduli of elasticity of the materials from which the two structures are constructed, taken in the same order as that used in determining n. Thus, in applying loads to the model the loads for which the actual structure was designed were divided by n^2m, and the resulting loads were applied to the model, giving unit strains in the model equal to those that would exist in the actual structure. The unit stresses in the actual structure would thus equal those in the model multiplied by m.

Huggenberger "tensometers," with a multiplication of about 1,000, were used in measuring the strains on ½-in. to 40-in. gage lengths. On a gage length

Fig. 1—Marked bending of the ribs at the deck intersection under lateral loading was accompanied by high secondary stresses, which indicated the need for strengthening the ribs at this point. Wind load on the upper part of the ribs is transferred to the deck here.

Fig. 2—A celluloid model 7½ ft. long reproduces the central span of Main Ave. bridge for measurement of secondary stresses under load.

of 1 in. a unit strain of 0.00001 can be measured, equivalent to a unit stress of about 3 lb. per sq.in. in the celluloid model and about 300 lb. per sq.in. in the actual steel structure. The sensitivity would of course be increased by using greater gage lengths, but the average strain over a long gage length might vary considerably from the maximum.

The model was found to be especially valuable in determining the relative value of various types of bracing as well as their effectiveness in equalizing load distribution. Careful studies were also made of stresses resulting from torsional moments.

Several points of high-stress concentrations were discovered. By modifying the bracing details it has been possible to reduce the stresses at such points. The greatest concentrations of stress in the arch rib due to lateral forces occurred near the deck intersections, where torsional moment combined with other forces. It was found necessary to add considerable material at these sections in order to stiffen and strengthen the structure sufficiently to resist these forces without stressing the material beyond the usual working values. The model was found almost invaluable in testing out various amounts and distributions of such reinforcing material.

The model was built and tested as a thesis project by R. O. Artner and J. F. Davis, two seniors in the department of civil engineering of Case School of Applied Science.

Concrete Partition Walls in Chicago Post Office

ERECTION of the new Chicago post office, covering an area of 800x344 ft., is well along toward completion. Pending publication of a complete description of this unusual work, several details of construction may be noted. As a protection against damage from trucks, some 160,000 sq.ft. of inside partition walls in the building is being constructed of 6- and 8-in. concrete slabs, with a sheet-steel protection at the bottom, as shown in Fig. 1. The 6-in. walls are reinforced with a single layer of 6x6-in. mesh, all No. 0 gage wire. The thicker walls have two layers of 9x9-in. mesh, all No. 0 gage wires. As the sheets of fabric are lapped 3 in., the outside longitudinal wires on one side of the sheet are spaced on 9-in. centers for the 6-in. mesh and on 12-in. centers for the 9-in. mesh. In consequence the 6- and 9-in. spacing is maintained except for the lap space.

Plywood forms

Plywood is used for the forms, which are separated by sheet-metal spacers bent trough-shaped (Fig. 2). The ends of the spacers have ears for bearing against the forms. The tongue of metal cut in the bottom of the spacer is locked over the fabric, holding the mesh in position.

Like the Chicago Daily News Building, the post office utilizes air rights over railroad tracks, and the smoke is collected in ducts and carried to a single smokestack.

In a smoke chamber or duct over the track floor chromium-steel rods are used as hangers. As a further prevention of metal corrosion from the sulphur fumes in the smoke, the 4x4-in. electric welded wire fabric in the concrete slabs and walls is galvanized, according to the American Steel & Wire Co., whose reinforcing mesh is being used.

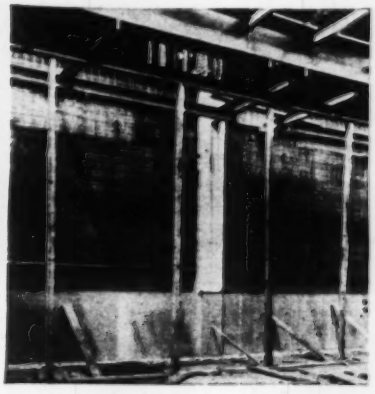


Fig. 1—Concrete partition walls, with steel-plate facing at the base to protect them from being damaged by trucks, are a feature of the new Chicago post office.

Fig. 2—Plywood forms are used, in which mesh reinforcing is fixed by means of special trough-shaped spacers.

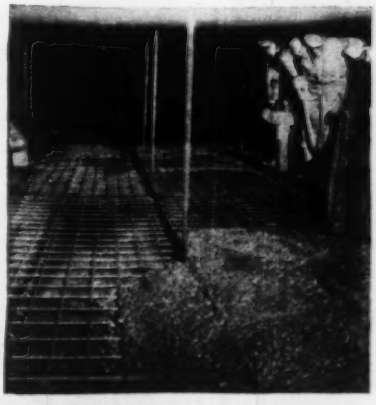


Fig. 3—As protection from sulphur fumes in locomotive gases, chromium-steel hangers and galvanized reinforcing are used in the smoke ducts.

New Materials Laboratory at Berkeley

University of California building provides for class and research work in testing and developing engineering materials—Equipment includes 4,000,000-lb. universal machine—Research on Hoover Dam concrete and San Francisco-Oakland suspension-bridge models

COLLEGE testing laboratories will always be important factors in advancing the development and proper use of engineering materials of construction. They perform the two valuable functions of giving basic instruction to undergraduates and providing facilities for original research. The first is essential in acquainting young engineers with the fundamental properties of those materials that they will later use in problems of design and construction. The second provides for the continual expanding of the field of use for engineering materials, the better understanding of certain physical and chemical characteristics and the development of new materials. Much of the success in teaching and research depends on the facilities available, and recent progress has been rapid in the improvement of equipment and methods. The present article describes the building layout and apparatus in the new engineering materials laboratory at the University of California, a notable example of the most modern development in college testing laboratories. —EDITOR.

A 4,000,000-lb. universal testing machine is the outstanding piece of equipment in the new engineering materials laboratory of the department of civil engineering at the University of California, Berkeley, which is designed and equipped to provide exceptional facilities for the testing and developing of materials for engineering construction. Intended primarily for undergraduate instruction, the laboratory has adequate provisions for research investigation and has already done extensive work on suspension-span models for the San Francisco-Oakland bridge and is at present at work on exhaustive research on cement and concrete problems connected with Hoover Dam. The new building forms a unit in the proposed plan for an enlarged engineering group on the campus and permits the removal of the laboratory from seriously outgrown quarters.

Building — The building contains 46,100 sq.ft. of floor area and is a U-shaped structure, 125 ft. wide by 242 ft. long. The natural slope of the ground provides four stories along the front with a single-story height at the rear (Fig. 1). Special details of construction include the use of partitions of light-weight, sound-absorbent concrete blocks made with porous pumice aggregate, and acoustic plaster in the offices and classrooms. These features are of particular importance in a laboratory building where considerable noise is inevitable, and they have proved very successful.

A 55-ft. clear height is provided at the ground floor, which extends the full 125-ft. width of the building and has a depth of 54 ft. This ground-floor area contains the 4,000,000-lb. testing machine in addition to several other large-sized universal machines. The entire ground floor and base of the big machine are accessible to motor-truck delivery. A view looking down the length of the main room is shown in Fig. 2. This floor also contains rooms for air compressors and refrigerating machinery.

The next or first floor is U-shaped in plan, with a length of 172 ft. in the wings. The front part of this floor level is occupied by the clear space over the large testing-machine room. One wing contains offices and service quarters, while the other includes several temperature and humidity control rooms for concrete investigations. The second floor, which occupies the outside limits of the building dimensions, provides a similar clear crane bay across the front over the large machines and contains offices and rooms for laboratory use and research in the wings. A small third floor provides further office facilities, computing rooms and research quarters and completes the required height of 55 ft. for the standards of the large testing machine. The layout of equipment and rooms on the three main floors is shown in Fig. 3.

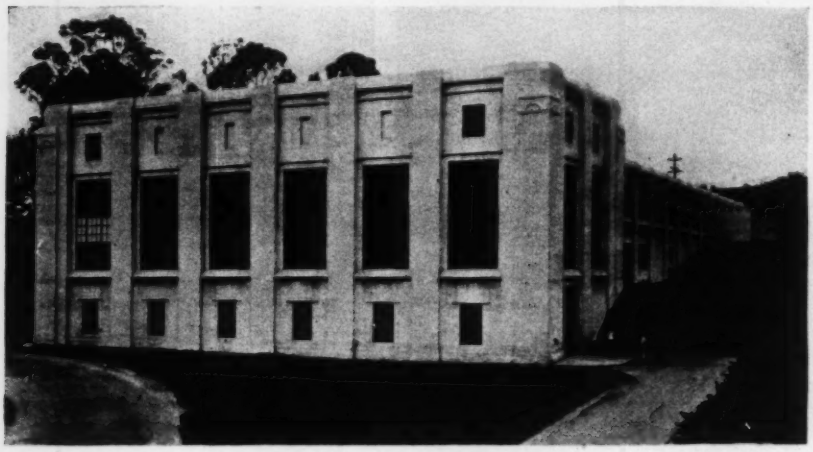


Fig. 1—Topography of the site of the laboratory provides four-story height in the front for the 4,000,000-lb. testing machine and, at the same time, permits truck delivery on three floor levels by sloping runways in the rear court between the wings.

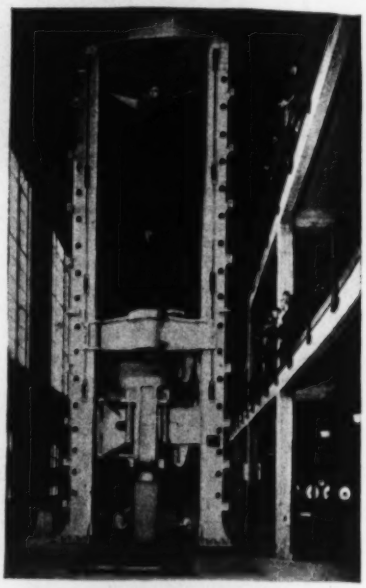


Fig. 2—Columns 33 ft. high can be tested in the 4,000,000-lb. universal machine that occupies the entire four stories at the front of the building. Note the control room at the right, 7½-in. steel-shaft test specimen in foreground, concrete cylinder under test and stepped balconies for crane delivery.

The balconies at the upper-floor levels overlooking the ground floor and main testing room are stepped back from the lower-level balconies to make possible the loading of heavy equipment from the 10-ton crane at any floor level. A large freight elevator is also provided to facilitate the handling of equipment or test specimens from one floor to another.

The topography of the location makes it possible to provide for deliveries by motor truck to the three lower-floor levels. An inclosed courtyard, 40x180 ft., is located between the two wings of the building, and provision has been made for the future covering of this courtyard with a glass roof. At present it affords opportunities for outdoor set-ups.

Testing-Machine Equipment — The

laboratory provides a total of nine universal testing machines, with capacities varying from 1,400 to 4,000,000 lb. The machines are of standard make and design, in general, with the exception of the record-breaking 4,000,000-lb. machine (*ENR*, Feb. 11, 1932, p. 217). On an extensive area on the second floor are grouped the smaller testing-machine units common to testing-laboratory work, which provide for investigating qualities of tension, compression, torsion, bending, impact, hardness and endurance.

In addition to this machine equipment for general materials testing, one room contains the usual equipment for the study of highway materials, including a smaller room with sound-proof walls for the rattler tests. Large and small core drills and carborundum saws are available for preparing test pieces of stone or concrete. Another room contains ovens and furnace equipment for heat-treating metals and for testing materials at high temperatures. A group of rooms in one wing houses the chemical and bacteriological laboratories for class work and research in sanitary engineering.

The soils laboratory is equipped for determination of the various characteristics of soils, including particle size distribution, shrinkage and liquid limit. Special equipment has been constructed for making consolidation tests of soils and for determining the action of soils under axial and triaxial loads. This equipment was used recently in a comprehensive investigation of undisturbed samples cored from proposed pier sites along the line of the San Francisco-Oakland Bay bridge. Methods of obtaining these clay samples were described in the issue of June 23, 1932, p. 891.

To facilitate the making of special equipment necessary for research investigations, the laboratory has a fully equipped machine shop, including a forge and welding room. In conjunction there are rooms for woodworking, sheet-metal work and painting. A precision room provides for making special instruments and delicate equipment.

Concrete Laboratory — In connection with the concrete laboratory there is a group of storage rooms for concrete specimens, providing unequaled facilities for temperature and humidity control. The mixing room contains the usual equipment for student work in cement, mortars and concrete (Fig. 5). Various sizes of motor-driven mixers are available. A feature of the room is the group of twelve aggregate-storage bins along the wall, which are filled by truck delivery from the outside.

The curing room adjoining the mixing floor provides a constant temperature of 70 deg. F. and a dense fog that produces 100 per cent relative humidity. This fog is developed by atomizers using compressed air, and the proper temperature is obtained by steam coils and refrigeration units. Following curing, the specimens may be stored in one of several control rooms under automatically regulated conditions of temperature and humidity.

One room provides for storage of concrete specimens in water tanks at a constant temperature of 70 deg. F. Another permits air storage at 70 deg. F. and controlled humidity of 70 per cent. The same temperature control but lower humidity, which can be established at 50 per cent or any other required point, is maintained in a third room. Conditions in these cork-lined control rooms are regulated by automatically operated air-conditioning equipment. Temperature control of the rooms is accomplished by thermostatically regulated steam coils and refrigeration units, all inclosed in a special air-conditioning compartment through which the air is continually circulated to insure uniform conditions in all parts of the room.

The humidity control is more complex, consisting of a mechanism operated by the expansion and contraction of several strands of human hair, which is very sensitive to humidity changes. Humidity higher than that desired causes an expansion of the hairs, making an electrical contact. This in turn operates an automatic damper in the air duct and diverts the air through a cold-water spray. The temperature of the air is reduced below the dew point, causing it to precipitate its excess moisture, and it is then passed through eliminators to separate any particles of water. Before returning to the room, the air is heated to the desired temperature. When the relative humidity drops, the controller contracts and breaks the electrical contact, which closes the damper on the spray chamber. The air is then merely bypassed around the spray chamber through the heaters or coolers and into the room again. In general, the control equipment provides for regulation within a temperature range of 1 deg. F. and 1 per cent relative humidity.

The control room for observation of low-temperature effect is lined with 12 in. of sheet cork and can be maintained at a temperature of —20 deg. F. Controlled variation in temperature is provided in a room that can be regulated between a temperature range of 10 and 140 deg. F. Freezing and thawing effects can be produced by regulation of these low-temperature rooms.

Fig. 3—Layout of three main floors, showing location of principal equipment and laboratories. Variable floor length is a result of the ground slope. All partitions are of sound-absorbent porous concrete blocks, and room temperatures are automatically regulated.

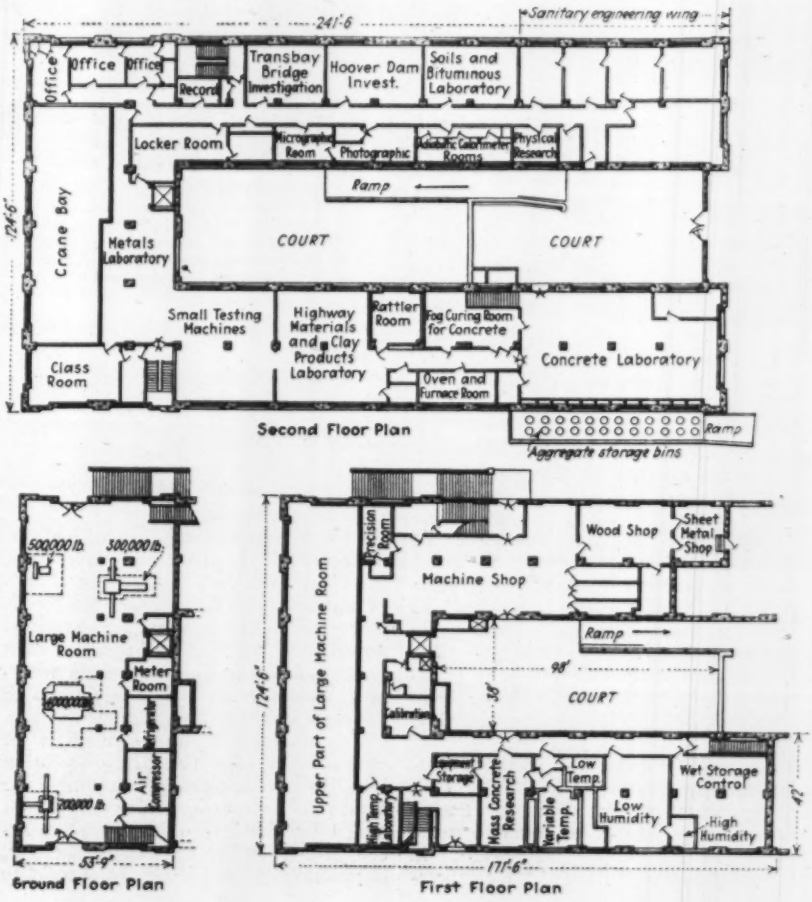


Fig. 4—Main testing room for students, showing some of the smaller-capacity machines.

Research—In addition to regular class instruction in laboratory courses, two major research studies have already been undertaken in the laboratory. The first was the testing of models of the San Francisco-Oakland bridge, which were the most extensive and elaborate models ever built for structural testing purposes. The second is the program of cement and concrete study being carried on as part of the research investigation in connection with Hoover Dam.

Design problems involved in the San Francisco-Oakland bridge resulted in the authorizing of extensive model tests as an aid in determining the relative advantages of alternate designs. These accurately designed models (*ENR*, June 9, 1932, p. 828) were constructed on small concrete piers set on the laboratory floor at a linear scale of one-hundredth of the proposed length of 10,000 ft.; one is shown along the wall in Fig. 2.

The research work on the Hoover Dam cement and concrete problems, now actively under way to determine the influence of chemical composition, fineness of grinding and other factors, has resulted in the development of special equipment to expedite the testing of a long series of standard and special cements for determination of relative heat of hydration and other properties of the resulting concrete. Tests are being made in specially built adiabatic calorimeters automatically controlled to provide conditions identical with those occurring in a massive structure. Air temperature in the calorimeter is maintained the same as that in the concrete specimen, to provide against heat loss or gain. The results indicate directly the temperature rise for adiabatic curing and permit calculation of the heat of hydration at various ages. Sealed specimens of mortar or concrete cured at relatively high temperature in the calorimeters are tested for compressive strength, durability and volume change.

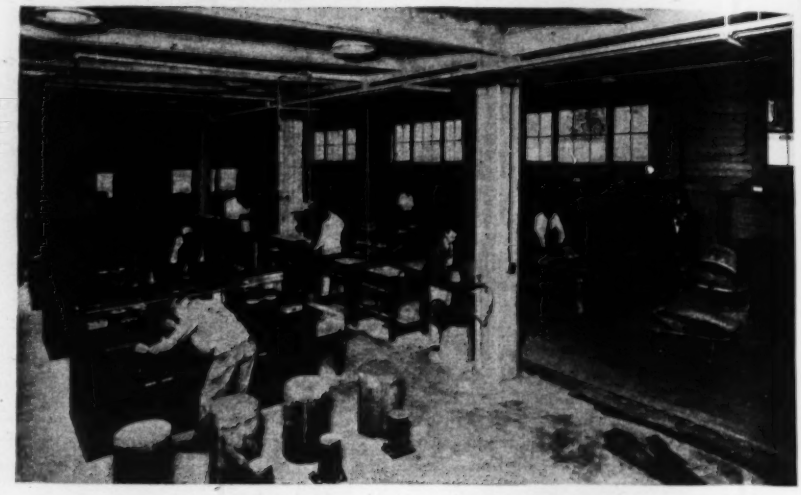


Fig. 5 — Cement and concrete laboratory, with aggregate bins along wall at right filled by direct truck delivery. Note simple structural framing providing clear areas, also exposed concrete finish.

As each cement requires the use of a separate adiabatic calorimeter for at least two months, the heat-of-solution method for determining heat of hydration is used for most of the work, the former method being used primarily as a check on the latter.

Using the heat-of-solution method, the equipment and procedure have been gradually improved by those in charge of this cement investigation until it is now possible to run a test for the determination of the heat of hydration of a cement sample in an hour. It is necessary, however, to cure the sample to the desired age before making the test.

The curing of the small vials of cement paste for the heat-of-solution tests, the volume-change bars and the cylinders for compression tests, all sealed against loss of moisture, is accomplished in special curing chests, electrically heated and automatically regulated to duplicate any desired time-temperature program. The automatic controller can be changed in a few minutes from one time-temperature curve to another. The method is a special adaptation of a stock temperature controller developed by the staff. The actual time-temperature program used in curing samples made of a given cement is previously determined by temperature rise observations on a large sealed specimen in a high-insulation calorimeter.

This program of research on cements is a part of the investigations being conducted by the Bureau of Reclamation for the purpose of writing the best possible specifications for the cement and concrete control for Hoover Dam.

The engineering materials laboratory is a part of the department of civil engineering, of which Dean Charles Derleth, Jr., is chairman. The immediate supervision of the laboratory is under the direction of Prof. Raymond E. Davis, assisted by Assoc. Prof. G. E. Troxell. A staff of about 30 technicians, including experts in the fields of electrical, mechanical and chemical engineering, is engaged on the research work now in progress.

Use of Water Power in Canada

In the last decade the use of water power as a source of energy in Canada has more than doubled in proportion to the population. An estimate upon this basis has been made by the Dominion Water Power and Hydrometric Bureau, which shows that between 1921 and 1931 the amount of power used per 100 of population rose from 31 to 64 hp., or more than 106 per cent. Installations in operation at the end of last year are estimated by competent authorities as equivalent to 15½ per cent of the present recorded water-power resources of the Dominion, placed at 43,700,000 hp.

Dredge-Made Island Drained for Mount Vernon Highway

Water-soaked sand and muck, held in impermeable dike ring, is unwatered by cutting off source of capillary draft from below, permitting muck to dry out

ABOUT 4,000 ft. of the Mount Vernon Memorial Highway (*ENR*, July 23, 1931, p. 124), leaving the Virginia end of the Arlington bridge across the Potomac, traverses the length of a hydraulic-dredge-filled island known as Columbia Island. This island had been built up over a period of years by successive hydraulic-fill lifts retained by impermeable dikes on the perimeter of the island. A part of the fill surface was virtually under water and too soft to be walked on; a larger part had a crust over soft material, and a heavy load would break through. No part was solid enough for a road foundation. The fill had to be consolidated. Soil analyses indicated the sand to be drainable and the muck to be practically impossible to unwater by ordinary drains. Unwatered, the muck would shrink greatly, and extra roadbed fill would be required to replace the shrinkage. Because of the stratification of the fill a method of unwatering the muck was offered by processes of draining the sand layers underneath muck layers. The processes are described in a report in *Public Roads* for June, 1932, by C. A. Hogentogler and E. A. Willis, engineers, Bureau of Public Roads. The following is a much-condensed abstract of this paper.

—EDITOR.

BORINGS made every 50 ft. along and on both sides of the center line of the Mount Vernon highway on Columbia Island brought to light several interesting and unusual conditions. The soil profile is shown in the accompanying sketch. The sand and muck occurred in layers and pockets varying from 1 in. to several feet in thickness. In places wet sand occurred above dry muck; in others dry sand over saturated muck; in others wet muck over wet sand; and in still others there was dry muck over wet sand.

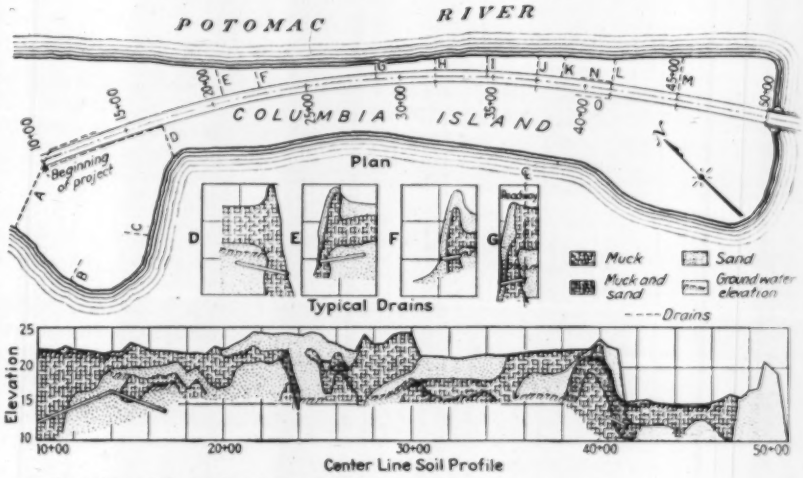
Finally, in several instances perched water tables were encountered. All of the free-water surfaces were above the elevation of the river; but in certain places free water occurred in several layers vertically above each other, with relatively dry material in between.

The comparatively small pockets of saturated sand and muck presented no particular difficulties. The prevailing condition, particularly in the area between stations 10 + 00 and 13 + 00, where the soil was the least stable, was that of a layer of saturated muck about 6 ft. thick underlain by a bed of saturated sand.

A consideration of the characteristics of this material furnished important information. Tests that showed how the fill would shrink if the moisture content were to be reduced from 115 to 31 per cent also showed that if this soil had a chance to dry out by evaporation, it would crack to such an extent that it would transmit water freely. If could be seen readily that if the water were taken away from the bottom of the muck, evaporation from the top would dry out the soil. These two factors pointed in only one direction, which was to drain out the sand layer and let the characteristic properties of the muck do the rest.

Plan of drainage

In general, the drainage plan consisted of three essential operations—namely, (1) removal of free surface water, (2) removal of brush and vegetation, and (3) tapping the impermeable dike and placing drains to remove all underground water trapped in layers or pockets.



Soil profile and drain plan for consolidating a hydraulic fill for road construction.

The surface water was removed from the wet area between stations 10 + 00 and 13 + 00 in an attempt to dry it up enough to make it possible to work in this area. Shallow surface ditches were dug from the dikes back toward the center line. A great quantity of water was carried off in this manner, and as soon as the water on the surface was removed a crust formed. This crust was not very thick, but as it dried out it began to shrink and crack, indicating that the soil would eventually become more stable if the free water were removed from it.

All underbrush and vegetation was cut from the right-of-way. This step very materially aided evaporation and speeded up the drying-out process.

In disposing of the underground water the first and most important step was to cut through the impermeable dikes. This step alone would in time have removed a great deal of the free water from the soil.

As it was necessary to begin grading operations as soon as possible, tile drains were installed in such a manner as to tap the water pockets and dry them up rapidly. The location and depth of the drains depended on existing conditions as determined by borings.

Where saturated sand was surrounded by muck the problem was simply to locate the lowest spot in the sand pocket and run a drain to that point.

In instances where wet muck was found over dry sand, drainage was accomplished by cutting a trench through the muck to the sand. The material close to the trench would begin to drain, and as it dried out cracks were formed. These cracks extended back from the ditch and served as water carriers, and so the whole area was gradually drained.

In the most common condition encountered, that of a layer of wet muck at the surface resting on a bed of saturated sand, tile drains were so placed that they would take the water out of the sand. With the removal of this water through cuts in the dike, the muck would have dried out slowly. Tile drains connecting these outlets with lateral drains along the roadway materially hastened the stabilizing action.

Successful consolidation

The quantity of water removed from June 13 to July 24 was 950,000 gal. Several of the drains have been carrying water continuously for nearly a year. Further evidence as to the amount of water removed may be obtained from a comparison of the thickness of the muck layer before and after drainage. Borings made 50 ft. to the right of the center line at station 17 + 00 before drainage revealed a depth of muck of 6 ft. Nine months later this had consolidated to 4.75 ft. This represents a loss of 54,450 cu.ft. per acre.

As a result of the drainage, this soil, which a few months before failed to support the power shovel on rafts, carried

heavily loaded material trucks, and grading was completed without difficulty.

The method employed was successful in this instance only because of the peculiar topographic features encountered in combination with certain physical properties possessed to such a marked degree by the muck soil. The decision as to proper methods of stabilization was possible only as a result of thorough knowledge of all the factors involved.

Structural Hazard of Earthquakes Measured by New Instruments

Strong earth motions, of which few measurements have been made, are observed by instruments of three new types distributed along the Pacific Coast and in other earthquake regions

By N. H. Heck

Chief, Division of Terrestrial Magnetism and Seismology, U. S. Coast & Geodetic Survey, Washington, D. C.

EARTHQUAKE STUDY has been highly active in recent years but has produced few data that can be used by engineers to improve the earthquake resistance of buildings, bridges and other structures. The need for such data was brought to notice particularly by John R. Freeman a few years ago. To meet the demand, a broad program of observations has been mapped out by the Coast and Geodetic Survey to measure the forces involved in the destructive effects of earthquakes. Instruments designed for the work are described in this article by Commander Heck, who is in charge of the program. —EDITOR.

THE SUBJECT of loss through earthquakes has recently been brought to the attention of engineers to a greater degree than ever before. Consideration is now being given in certain localities to stresses due to earthquakes in the design of large buildings and of other large structures such as bridges and dams. Theories have been developed, but it is an outstanding fact that thus far few accurate measurements of strong earth motions have been made, and none have been made in this country.

It is to obtain this information that, as a result of interest from engineering groups in the subject, the federal government and several private organization have been active during the past year in developing instruments for recording strong earth motions. The Coast and Geodetic Survey has had an appropriation for this purpose, and as a result partly of this and partly of activity at two institutions of learning several types of instruments have been developed and constructed and are now being installed.

There are three types of instruments —accelerometers, displacement meters and the Weed strong-motion seismograph, which latter probably comes more nearly in the first class.

Wenner Accelerometer—A complete accelerometer instrument (Fig. 1) consists of three accelerometers of the type developed by Dr. Frank Wenner, of the Bureau of Standards. Each accelerometer has as its essential feature a vertical quadrifilar suspension, to which is attached a vane that serves the double purpose of steady mass and damping vane (Fig. 2). To the vane is attached a tube of small diameter. The suspension is in four parts, although it actually consists of two single continuous wires of stainless steel, threaded up and back through two pairs of holes at the top and clamped at the bottom. This would give a square cross-section of the same size throughout. However, each pair of wires passes through the tube attached to the vane and is kept from slipping by small plugs at each end. The form of the suspension above and below the tube is therefore pyramidal, which reduces the likelihood of so-called violin-string motion of the suspension when the whole apparatus is shaken severely. The vane is in the field of a strong cobalt steel magnet, which provides the necessary damping. A small mirror is attached to the vane, and a beam of light reflected from this mirror is photographically recorded. There is little difference between the three accelerometers, which are substantially alike and are set so as to record the vertical and two horizontal components of the motion; prisms produce the necessary change of direction of the light beams to bring them all parallel and a short distance apart. Automatic recording apparatus for the Wenner instrument has been developed by members of the Coast and Geodetic Survey, H. E. McComb, D. L. Parkhurst and Edward C. Robison.

The recorder is always at rest except when an earthquake occurs. As soon as earthquake motion of a certain intensity has been reached, the light is turned on, the drum starts rotating, the time-marking device is in operation, and in a few seconds a buzzer announces that an earthquake is going on. This would probably be known otherwise, but the buzzer is a precaution in case the earthquake happens to be near the lower limit at which the instrument would respond, or in case the apparatus should be set off by some other type of shock. The details are so arranged that the drum makes 1⅓ revolutions, then automatically stops and the light goes off. If the shock is still strong or if another shock occurs soon after, the drum starts again and the record is superimposed. This can repeat at least three times, a provision based on the fact that sometimes three strong shocks occur in sequence. There is no way of knowing in advance which will be the strongest; as this is the one in which the engineers have the most interest, the superimposing of records is less important than it would be otherwise. The time mark is placed to one side of the record, and therefore it is not lost in the strong motions as it

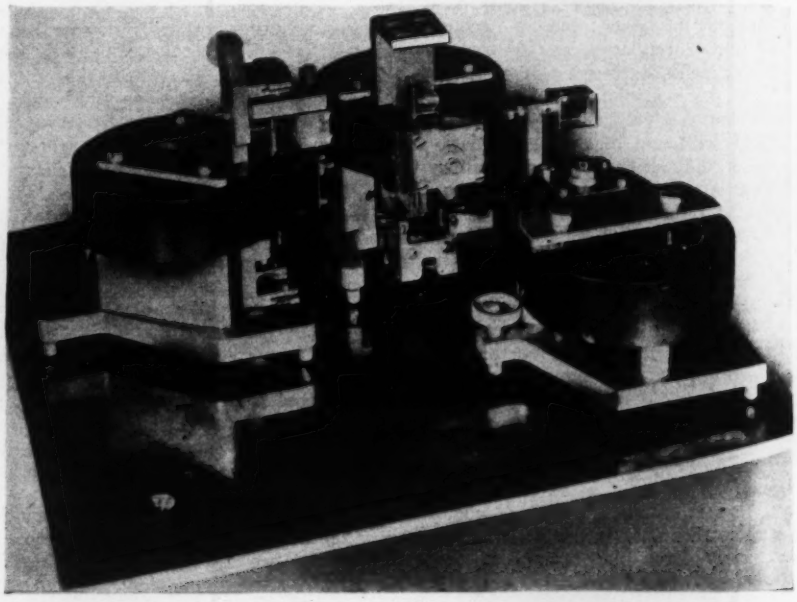


Fig. 1—Three-component Wenner accelerometer produces three records on a single drum by light beams reflected from mirrors on swinging loops of 0.1-sec. period. The three units are shown without the recorder.

would be if it were part of the earthquake record.

Both clock and motor drives have been worked out, the latter being principally used. The apparatus operates on dry cells, so that it will not be affected by failure of electric power at the time of the earthquake. Instruments may be seen in operation at Washington, San Francisco and Los Angeles, and probably in other parts of the country at a later date.

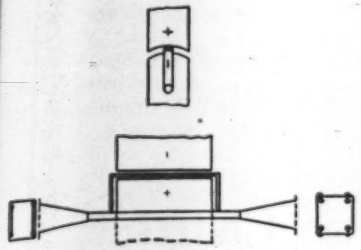


Fig. 2—Suspension system of Wenner accelerometer, comprising a vane swinging between the poles of a damping magnet, an axis tube and a quadrifilar suspension passing through the tube. For the vertical component the axis is horizontal as shown; for the horizontal components the axis is vertical.

The starting device is an important feature, since it determines whether earthquakes of less intensity than desired are recorded or whether it is to respond to the stronger shocks. The device now in use is a contact accelerometer developed by M. W. Braunlich, of Massachusetts Institute of Technology, acting under the general direction of Prof. Geo. A. Hosmer. This instrument is so designed that when a certain acceleration (never less than 0.05 g. but sometimes as high as 0.1 g. where there may be other serious vibrations in the vicinity) is reached, a circuit is broken, starting the recorder.

Experiments have shown that an accelerometer record gives an average accuracy within 5 per cent, the maximum error being 10 per cent. This is all that is obtainable at reasonable cost and should meet all the needs of the engineer. The accuracy depends on the period of the accelerometer, and an ingenious utilization of the synchronous-motor principle makes it possible to adjust the period to the precise amount desired, which is of the order of 0.1 sec.

The Displacement Meter—Buildings are subject to two types of earth motion: first, shocks that have high acceleration, and second, sway of the entire structure set up because the period of the structure is close to that of the earth wave. The latter motion occurs only in earthquakes continued for some time, especially when the origin is not immediately beneath the structure and in the case of certain depths of alluvial material. The accelerometer tells little about these motions because they have low acceleration and a much longer period than that of the accelerometer. However, another type of instrument, the displacement meter, which is an ordinary seismograph of low magnification, will give this information. The displacement meter has the boom and mass of the ordinary seismograph and is equipped with an automatic starter that functions when the displacement of the boom reaches a certain predetermined value. Special precautions are then taken to prevent the cup from leaving the pivot, since in the case of the Japanese earthquake of 1923 this form of accident resulted in the loss of many records and severe damage of the instrument.

Weed Instrument—A third instrument is less expensive and simpler and occupies less space. It is intended to be entirely mechanical, but for the present it requires an electrical starter, since a satisfactory mechanical starter has not yet been devised. This is the device developed by Arthur J. Weed, of the University of Virginia. It is in effect an inverted pendulum of 0.1-sec period, properly damped, which makes a record through two styluses pressing against a smoked-glass plate. A single pendulum gives two records at right angles, as in the case of the Wiechert seismograph, used for recording distant earthquakes. It is somewhat more difficult to interpret these records directly as accelerations, but there is every reason to believe that when they are compared with those from other instruments the Weed instrument will be found to give consistent performance and therefore will be useful not only in indicating comparative intensities of earthquakes but also in yielding fairly correct values of accelerations.

First Installations on the Coast—The instruments are being installed in Southern California, the San Francisco Bay region and in the vicinity of Eureka. Demands from engineers and architects on the Coast were such that this region was given first consideration, though it is recognized that other parts of the country also need such instruments. There has been a great deal of cooperation in the form of providing sites and advice as to the best localities to obtain the desired results. While the first instrument was installed on June 15, no records have as yet been obtained. That results will soon be obtained is indicated by the fact that the earthquake of June 6 at Eureka, Calif., was of sufficient intensity to give a record.

While the number of installations for the present is limited, an effort is being made to cover a variety of conditions. Several instruments will be placed in basements of buildings, one on the Suisun Bay bridge of the Southern Pacific Railway in California, and several will be so placed as to reflect the influence of widely varying geological conditions in a short distance.

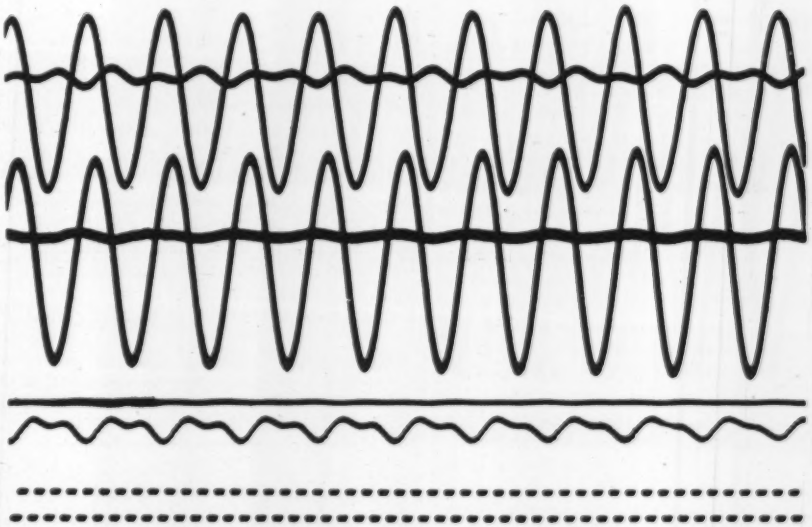


Fig. 3—Shaking-platform record of three-component Wenner accelerometer. This is part of the record for two turns of the drum, the first turn with platform swinging, the second with platform nearly at rest. East-west component at top and north-south component next below have the record of the second turn passing through the middle of the record of the first turn. Vertical component, near bottom, shows the effect of the platform swinging through an arc on the first turn (lower curve). Dots at bottom are time marks for every half second.

It should be understood that this program of observation will not result immediately in better design of structures. It is first necessary to await an earthquake, then to compare the effects on existing buildings with the records obtained in the vicinity, and finally to develop principles of improved design based on this complete information. Since even buildings specifically designed to resist earthquake effects do not escape damage entirely, it is going to be both interesting and important to correlate the damage with the recorded motions, and it is hoped that to accomplish this it will be possible to place instruments in several parts of the same building.

Engineering Society Maintains Regional Planning Division

SINCE 1928 the Cleveland Engineering Society has had an active participation in regional engineering through its regional planning division. Objects have been to study utilities, transportation and zoning. Accomplishments are shown on three sets of maps of the county, one showing existing and planned sewers and sewage-treatment works, one showing existing and planned water supply, treatment and distribution works, and one showing the existing use classifications in the zoned parts of the county.

Leading up to the entry of the society on this work was the organization in 1927 by engineers and officials representing most of the municipal divisions of the county of the Cuyahoga County Planning Congress. A map showing a system of suggested major and secondary arteries was presented to the county commissioners. This was about the time a study of a ten-year plan for highway improvement in the Cleveland region was begun by cooperation between the county officials and the U. S. Bureau of Public Roads (*ENR*, Jan. 28, 1929, p. 152). The report of this work was published in 1928, and steady progress has been made in carrying out the recommendations by state, county and municipalities. The society division was formed by the same engineers who had been active in the Cuyahoga County Planning Congress.

The question of water and sewer service is simplified by the fact that the city of Cleveland furnishes all of the water for the district and to a considerable extent the main sewer outlets. Besides this a large proportion of the water and sewer extensions made outside the city in the last ten years have been planned and built by the county sanitary department in county sanitary districts. All of the local transportation, both by streetcar and bus, is furnished by the Cleveland Railway Co., whose expansion and operation are controlled to a large degree by the city council.

Cleveland and all of its more populous suburbs as well as at least 50 per cent of the area of the rest of the county are zoned. The area remaining unincorporated in the county is negligible. The city water department and the county sanitary office make a practice of use-zoning undeveloped property in planning future extensions.

As yet the regional planning division has done little but lay the groundwork for a coordination of plans for like services in the many governmental units in the district and for the interlocking of plans for the different classes of development in the entire area. It is the hope of those active in the division that this beginning will create enough interest in the subject to lead to the creation of some official regional planning body, which will be adequately financed to prepare and help to direct the execution of a comprehensive regional plan and will act as a coordinating agency not only between different governmental units but between the divisions responsible for the various services within those units.

Charles E. Conley, city planning engineer for Cleveland, is chairman of the division, a position held until recently by C. W. Courtney, president, Courtney Engineering Co. Morse W. Rew, manager of the bus department, Cleveland Railway Co., is vice-chairman, and C. H. Hutchinson is recorder of the division.

Production and Costs Charts Speed Road Grading

By Mack Graham
Civil Engineer, Princeton, W. Va.

ON MANY road-grading operations in Kentucky and West Virginia in which the writer was associated with the contractors a decided increase in efficiency was produced by a timing and charting system operated as follows:

By means of a stopwatch an efficiency check was made of the various machines, and it was discovered that the total project efficiency was slightly above 50 per cent. The machines were capable of doubling their production, provided the lost motion could be eliminated. This lost time was calculated into dollars and cents on the basis of past production, and a detailed report was supplied the superintendent and each foreman, and each item of lost time was carefully discussed and suggestions made as to the remedy.

Twice each week thereafter these efficiency tests were made and reports given to the foremen and superintendents. The weekly rating of every foreman as to his production and cost of operation was posted on the bulletin board at the field office. The operators of the various machines were also rated according to their production, and on the machine having the highest record a small tin plate bearing the words "This machine highest record for the week" was placed in a conspicuous place. This publicity quite effectively developed competition among the various operators and foremen, and Fig. 1 shows the results.

The weekly cost record of each foreman was also plotted as a graph (Fig. 2) on which appeared a heavy red line or danger line. This line might be called the profit-and-loss line. Each week that the unit cost of a foreman's operations ran above the danger line this was shown in red ink, and when below the profit and loss line it was shown in black. These graphs were supplied the foremen and discussed with them, thus utilizing the idea that one picture is worth a thousand words, as everyone knows what red and black means in costs.

The competitive spirit among the employees could be readily recognized. In production it meant an increase of about 20 per cent, and in costs a decrease of about 15 per cent. The cost of the method is negligible.

Fig. 1—Curves of output, cost and efficiency of machine operations on road grading. Note effect of winter weather on results.

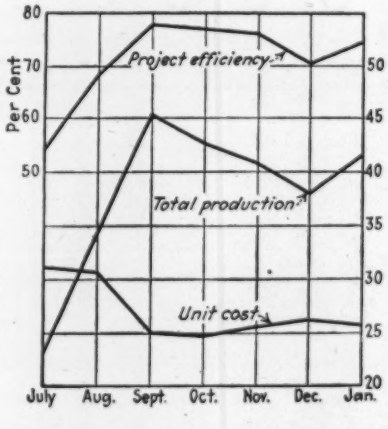
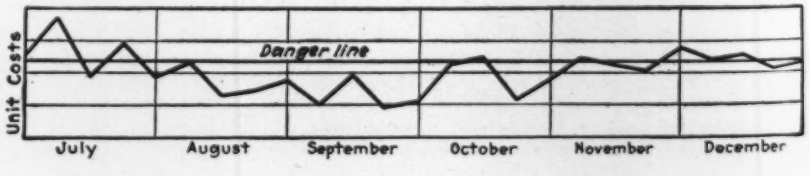


Fig. 2—Curve of weekly cost record, showing each foreman whether his work was a profit or loss.



Design Notes on Circular Concrete Bins for Grain Storage

Principal problem centers on loads in interstice bins that cause appreciable moments—Bins in contact are more economical than spread bins in spite of smaller storage volume

By H. H. Frenzel
Western Springs, Ill.

SINCE moving forms have come into general use, concrete has supplanted to a great extent the use of other materials in the construction of storage bins for grains and similar materials. The general form of these bins has been circular, with diameters varying from 15 to 30 ft. or more. The height varies from 50 to 120 ft.

The arrangement of these bins has also varied considerably. The common arrangement places the bins in rectangular rows with bin walls in contact, forming inner spaces or interstice bins. This arrangement has been modified at times by spreading the bins in either one or both directions, connecting the circular bin walls with short straight walls. Outer pockets are sometimes added. These common arrangements are shown in Fig. 1.

Competition has exerted considerable influence on the arrangement of bins, the effort being to increase storage capacity with the minimum addition of walls. This has been accomplished by the use of larger bins and by the spreading of bins as noted.

In the design of deep bins Janssen's formula, as given in Ketchum's "Walls, Bins and Grain Elevators," is the one in common use. Grain and similar materials act as semi-liquids in a deep bin, the lateral pressure at a given depth being uniform on the walls of the bin, and the circular bin is the natural form for this type of loading. Tension is the only stress in the walls, except the vertical stress due to the weight of the concrete and the grain load on the walls.

When an interstice bin is loaded, however, and the surrounding circular bins are empty, a different condition exists. Here the load is on the outside of the circular arc. The same law of stresses that applies to the circular bin does not apply, for there is nothing to furnish an unyielding abutment, a condition necessary if the stress is to be pure compression. A logical assumption in this case seems to be that the reaction from each interstice bin wall is balanced by the reaction from the adjacent wall, as shown in Fig. 4. This would be accomplished by the contacts where the bins are so placed and through the joining walls where the bins are spread.

Thus the interstice bin is a structure in which the members are subjected to moment. In general practice the steel is computed for the circular bins, and with the exception of the contact anchors no more steel is added. The partial failures that have been experienced in some structures would seem to demand that more thought be given to the design of this part of the structure.

Computations have been made for a few typical arrangements of bins based on the direction of reactions, as shown in Fig. 4. The loading is for wheat, using Janssen's formula with the following values:

$w = 50$ lb. per cubic foot.
$\mu = 0.4167 =$ tangent $\theta =$ coefficient of friction of wheat on bin walls.
$k = 0.6 =$ ratio of lateral to vertical pressure.

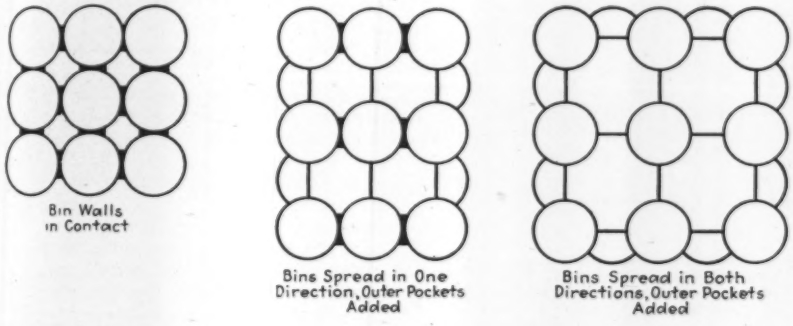
A constant moment of inertia was assumed for the walls in each problem. Moment and thrust diagrams are shown in the accompanying illustrations. The shears where the bins are in contact are small and can be neglected, but where the bins are spread the shears would have to be considered in the design.

Three problems are presented in Fig. 4 for bins in contact: a 21-ft.-diameter bin with a 7-ft.-wide contact; a 24-ft.-diameter bin with an 8-ft. contact; and a 30-ft. bin with a 9-ft. contact. The moments in the 21-ft.-diameter bin are small. The moments and thrusts in the 24-ft. bin are larger but still could be cared for with a 7-in. wall, which is ordinarily used for this size of bin. In the 30-ft. bin the moments are of such size as to require a somewhat thicker wall and a different arrangement of steel than is the general practice.

In Fig. 2 are shown the moments and thrusts for a 24-ft. bin spread 6 ft. in each direction. It will be noted that the moments are large in this case.

Fig. 3 shows the moments and thrusts for a 24-ft. 7-in. bin, spread 5 ft. 5 in.

Fig. 1—Common arrangements of circular concrete storage bins. Grain in circular bins causes pure tension in walls, but storage in interstice bins sets up appreciable moments.


Bin Walls in Contact
Bins Spread in One Direction, Outer Pockets Added
Bins Spread in Both Directions, Outer Pockets Added

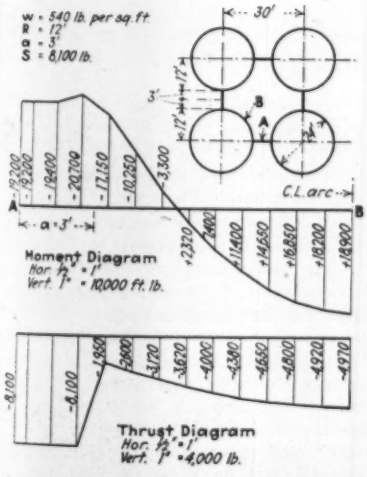


Fig. 2—Moment and thrust diagrams for 24-ft.-diameter bins spread 6 ft. in both directions. Load is in interstice bin, and the circular bins are empty.

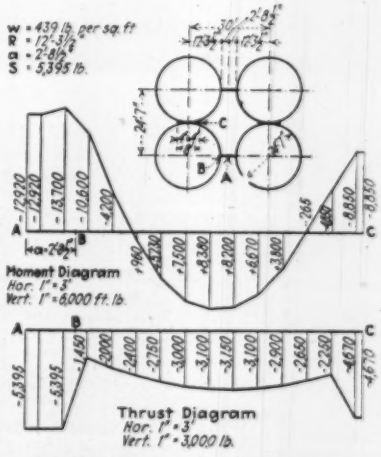


Fig. 3—Moment and thrust diagrams for 24-ft.7-in.-diameter bins spread 5 ft. 5 in. one-way. Load is in interstice bin, and circular bins are empty.

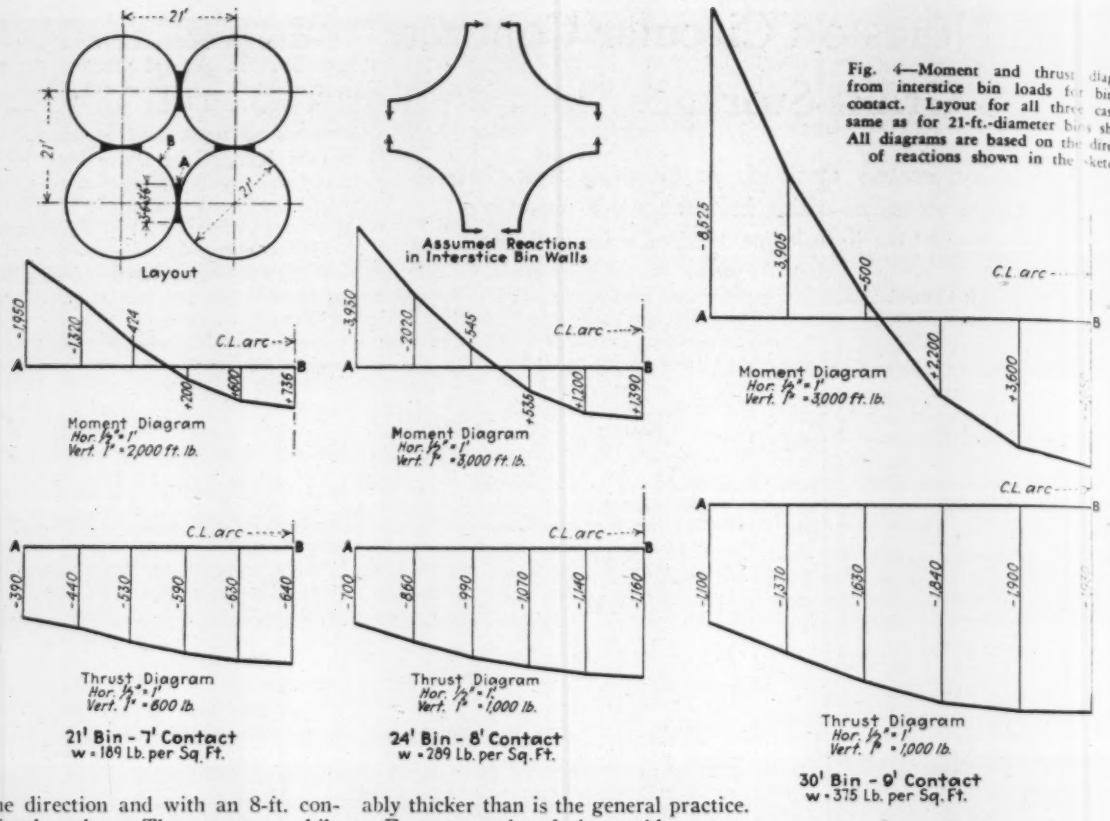


Fig. 4—Moment and thrust diagrams from interstice bin loads for bins in contact. Layout for all three cases is same as for 21-ft.-diameter bins shown. All diagrams are based on the direction of reactions shown in the sketch.

in one direction and with an 8-ft. contact in the other. The moments, while considerably smaller than in bins that are spread in both directions, are still quite large.

For both problems with spread bins the walls required would be considerably thicker than is the general practice.

From a study of the problems presented it would seem logical to conclude that spread bins are not desirable, and that any economy gained in extra storage would be more than offset if the inclosing walls for the interstice bins were designed to care for the increased stresses. The arrangement of bins in contact seems the more desirable. The stresses in bins up to 24 ft. in diameter are not excessive.

New Road-Mix Method Used on Ohio Roads

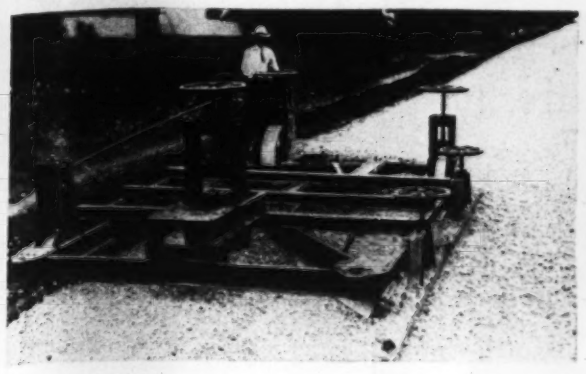
With a leveling hone and a pin planing mixer, road-mix surfaces are constructed with fewer machine operations and less bituminous binder

SEVERAL road-mix resurfacing operations have been carried on in Ohio this year and also in 1931, a new equipment method being used. A special hone reshapes the old road and shapes the resurfacing material, and the mixing is done with a multiple-pin combination harrow and drag. The new aggregate is rough-spread, the oil or tar is applied, and the road is rolled by the usual equipment. Construction has varied. The old road surface may or may not be primed to receive the new aggregate, and a seal coat and chips may or may not be used. In brief, the distinctive characteristic of the new method is the spreading of the aggregate to profile by a single pass of the hone and the mixing of the binder and aggregate without shifting the spread surface and with a double pass of the pin harrow and drag.

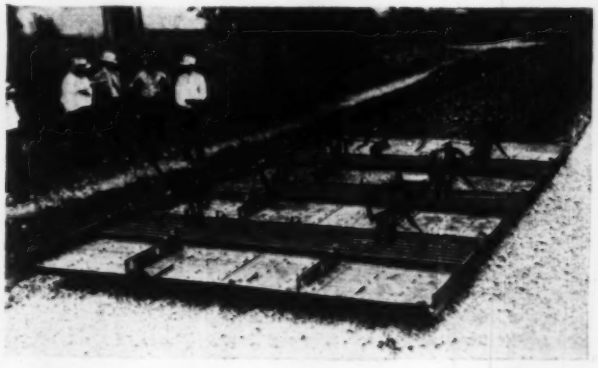
Methods and equipment are best made clear by a specific operation, and that on Route 71 in Darke County, carried on this year, is chosen. The old road was well compacted and had a worn-out bituminous top. Its profile was sufficiently good without reworking to apply the new aggregate directly on the surface but somewhat thicker on the lower slopes to take out the old high crown. This aggregate was ¼- to 2-in. crushed gravel, and it was distributed by spreader boxes behind trucks in two ribbons 8 ft. wide. Enough material was deposited to spread out to a width of 20 ft. in a volume of 175 lb. per square yard. The spreading to full width was done with the special hone previously mentioned. It is shown in Fig. 1.

This hone has a rectangular steel frame carrying three heavy spreader blades, and it is wide enough (11 ft.) to cover half the width of the road. On one side, that next to the center of the road, the frame is mounted on a steel runner long enough to span surface irregularities. On the opposite side, next to the road shoulder, the frame is mounted on a front and a rear wheel, which can be adjusted vertically as the operator desires to compensate for dips in the shoulder contour. With a low center of gravity and a weight of 4 tons, this plane has a powerful blading action. It was hauled by a 50-hp. tractor, and one pass down one side of the road and back on the other side completed the leveling.

The binder was applied, ½ gal. per square yard, by a standard pressure



Leveling hone on runner and wheels smooths truck-spread aggregate in one down-and-back trip, covering half the width each way.



Multiple-pin planing mixer completes bituminous mix in two down-and-back trips, covering half the road each way.

distributor and was mixed into the aggregate by the multiple-pin drag and plane shown in Fig. 2. The mixer is a combination of harrow and drag. The main body of the mixer consists of a large plane, 11½ ft. wide and 21 ft. long. This plane has a series of holes on 4-in. centers, alternate rows staggered, through which protrude pins that are attached to a steel grid vertically adjustable with reference to the plane, thus providing an adjustment range up to 4 in. The plane is built of 1-in. planks, steel-lined top and bottom. For convenience in handling, the mixer is built up in 3-ft. sections, rigidly tied together, a plane section on each end, with alternate pin and plane sections between. Each pin section carries 301 pins, or 903 pins to the mixer. The set of these pins is controlled by hand levers, one at each end of every pin section. Pins can be set at uniform depth or can taper from full depth at one end to flush with the plane at the opposite end for wedge-course operation. Heavy counterweights on levers maintain the desired setting. The levers can be set to bring all pins flush with the plane for short transportation, crossing bridges or railroads.

The mixer was hauled by a 50-hp. tractor down and back on each side (two trips) of the road without turning, as the hitch can be made at either end. The passes completed the mix and left the surface smooth and ready for rolling. After rolling, 0.2 gal. of binder was applied and allowed to penetrate six or eight hours, when the road was again rolled. No blotter course was applied.

Based on the experience on this and previous operations, the following general determinations appear reasonable. In leveling the aggregate the hone made a speed of 1.4 miles an hour, which would indicate a possible performance of 4 miles of 20-ft. grading per eight-hour day. The mixer made a speed of 1.8 miles an hour, which, with double mixing, would indicate a possible performance of 2 miles of 20-ft. surface mixed in eight hours. In surfacing Route 54 in Campaign County, Ohio, in 1932, one hone and two mixers placed 4 miles of 20-ft. road mix in one day. On Route 71 four men operated the tractor, one hone and one mixer.

The machines described were developed with the assistance of the engineers of the Ohio highway department working with the Perry Equipment Co., of Sidney, Ohio. The work described was done under the direction of H. S. Perry, assistant chief engineer of maintenance, and R. C. Bowman, assistant division engineer of the Ohio highway department.

Barrel Arch Without Spandrel Walls Carries Road Over Australian Stream

A CONCRETE-ARCH bridge of unusual though simple design has recently been erected over Walker's Creek, near Yass, Australia. The fill for the road is continued over the bridge, the arch ring widening toward the springing line to conform to the slopes of the fill.

The floodflow of Walker Creek required 300 sq.ft. of waterway only, but there was also high flood backwater to be provided for from the Yass River near by, into which the creek discharges. The velocity of this backwater is always low. Rock foundations were available.

The conditions were found to be most economically met by the construction of an arch of 60-ft. span and 19-ft. rise, the barrel of the arch being extended to the slope of the embankment on each side, thereby eliminating the need for spandrel walls or other method of retaining the filling. The depth of the filling is 1 ft. at the crown and 16 ft. at the springing line. The arch ring is 77 ft. wide at the springing line with a thickness of 18 in., and 32 ft. wide at the crown with a thickness of 15 in. Reinforcement near each face consists of ⅞-in. bars on 8-in. centers parallel to the roadway and ⅝-in. bars on 18-in. centers at right angles. The two grids so formed were tied by ⅝-in. stirrups 3 ft. 2 in. apart longitudinally and 1 ft. 4 in. apart transversely.

The work was carried out by the Charles Hardy Construction Co. on behalf of the main roads board of New South Wales, the final cost being $12,000 (at $4.86 = £1.).

Width of arch ring increases toward the abutments, conforming to the slope of the road fill.

One-Piece Rail Lock for Bascule Bridge, Wabash Railway

By S. M. Smith
St. Louis, Mo.

AT THE TIME of the erection of the double-track bascule bridge carrying the Wabash Railway across the Rouge River at Detroit, Mich., a rail-lock design consisting of two pieces was installed; one piece was for the running rail, of manganese steel, and the other was for the inside guard-rail, of carbon steel. At each of the eight rail joints separating the bridge tracks from the approach tracks these two castings were attached to the end of the bridge rail by means of four machine bolts passing through the web of the track rail. As the manganese casting rested on the flange of the stock rail, which has a 13 deg. slope, a tensile stress in the bolts was caused with the passing of every wheel load. It required constant maintenance to keep the bolts tight, but these rail locks were continued in service until about two years ago, when it became necessary to replace them on account of their worn condition.

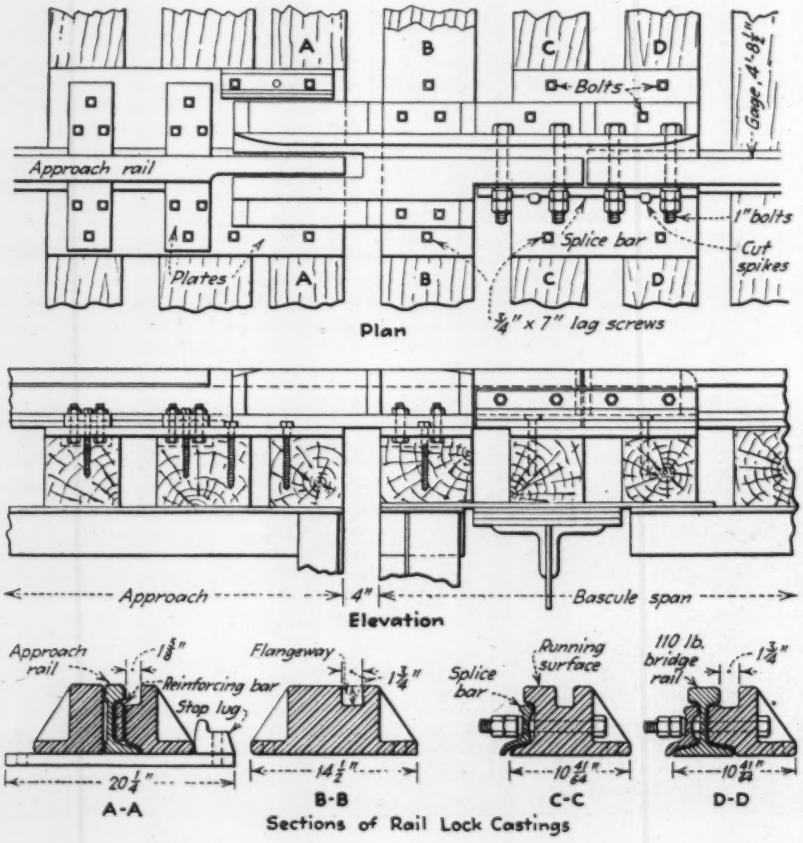
To eliminate the undesirable features of the first lock design, a rail lock consisting of a single manganese-steel casting was devised, replacing the two castings of the original design. The new construction, shown by the accompanying illustration, eliminates all stress in the horizontal bolts due to live load, because the casting is level on the bottom and rests directly on the base plate that carries the rail. This design requires the base and head of the rail on the fixed approach spans to be coped out, but a bar was welded to the web of the rail, as shown, in order to strengthen the section and compensate for this cutting away of the metal.

The rail lock is attached to the 110-lb. bridge rail by means of a single standard angle bar on the outside of the rail and four 1-in. bolts that engage the angle bar, track rail and rail-lock casting. On the bascule span, therefore, the standard rail end can be utilized without alteration. Each lock casting, weighing about 540 lb., is 4 ft. 2 in. long. It projects about 16 in. beyond the end of the bascule deck, so that with the bridge closed the casting has a bearing about 12 in. long on the deck of the approach.

On both the bridge and the approach decks the casting rests upon a heavy base plate attached to the ties by screw spikes. At its rear end the casting is shaped to receive the bridge rail, which is secured to it by a splice bar and four through-bolts. At the forward or projecting end it is socketed to engage the end of the track rail on the approach for a length of about 12 in. End locks center the span as it lowers, so that the socketed castings engage the rail ends accurately, and an angle bracket on the approach deck holds the casting in line. The locks for the trunnion end and forward end of the bridge are practically identical.

These new rail locks were designed by the writer, who was assistant bridge engineer of the Wabash Railway at that time. They have given very satisfactory service. The daily train movement is very heavy in each direction, as the bridge is used by four railroads.

Single casting forms rail lock spanning opening end of bascule bridge.



Sections of Rail Lock Castings

Retaining Basins in Sewer System in Germany

The city of Bonn, Germany, occupying the banks of the Rhine River for about 6 miles, is sewered on the combined system. Stormwater has greatly overtaxed the capacity of the system at times so that cellars have been flooded and unsanitary conditions created. Consideration was given in 1912 to the construction of stormwater interceptors to lead the surface drainage to the Rhine River, but this was found to be too expensive. Instead reservoirs were constructed in the sewer system to provide for the large quantities of surface drainage and to even out the load on the system.

Open reservoirs were used on the sewers bringing stormwater from suburban areas. On other parts of the system covered retaining reservoirs were formed by enlarging the sewers. The size of the covered basin was determined by the width of the street, the elevation of the sewer and the height of the house connections. There have now been 280,000 cu.ft. of storage capacity provided by covered reservoirs and 320,000 cu.ft. by open reservoirs.

These reservoirs proved their value recently during two heavy storms. No sludge deposits were created in the reservoirs. On the contrary, the discharge following the storm had the effect of flushing out the sewers.

Reservoirs of this nature cost only about 40 per cent as much as those of equivalent interceptor capacity and cost only 70 per cent as much to operate. In the case under discussion the basins were designed on the basis of a storm period of 10 min. and an intensity of 17.1 gal. per second per acre.

Abstracted from an article by Ferdinand Franken, which appeared in *Gesundheits-Ingenieur*, 1932, pp. 232-236 and 246-250.

Letters to the Editor

Pressure Distribution in Soils

Sir—The article by Prof. Karl Terzaghi in *Engineering News-Record* of Aug. 11, p. 158, states that the theory of pressure distribution proposed by the writer and amplified by Professor Housel assumes "that the value of the coefficient of incompressibility is constant to a certain depth H, and equal to infinity below this depth." While I have not checked Professor Housel's bulletin as to any warrant there for this statement, apparently Dr. Terzaghi did not observe the distinction made in the original exposition (*Trans.*, Am. Soc.C.E., Vol. 93, pp. 308-9) between plastic compressibility and elastic deformation at the limiting depth. The theory as originally proposed does not make the assumption of a sudden transition from a finite value of the coefficient of compressibility to an infinite value but merely assumes that the deformation passes from the plastic range to the elastic range at a certain depth. This assumption is almost axiomatic and is entirely in accord with factual observations, so that it can scarcely be said to be arbitrary.

Foundation soils other than solid rock are so infinitely variable in their physical composition—mineralogy, density, shape and size of grains, colloidal content and water content—that a definite prediction of their behavior based entirely on a study of soil physics is impossible. Progress will result from improvement in the observations of soils as they occur in place.

Therefore, the most promising procedure lies in the direction of better technique in making soil tests, more discernment in their interpretation and economical methods for more thorough exploration to determine the nature of underlying strata and of probable water movement.

C. C. WILLIAMS,
Dean, College of Engineering, State University of Iowa.

Iowa City, Ia., Aug. 18, 1932.

Azimuth in Low Latitudes

Sir—In low latitudes the standard Polaris methods for azimuth cannot be used. This was brought to the attention of the writer by a letter from an engineer working in Venezuela. He was using equal altitudes, but this involved a long wait and a second setting up of the transit instrument, which decreased the accuracy.

It occurred to the writer that the objections to equal altitudes could be met by observing two stars at nearly the same declination on opposite sides of the meridian. In the summer months the stars in Ursa Major (the Dipper), west of the meridian, and in Cassiopeia, east of the meridian, are excellent for a test of the new method.

Let us denote the azimuth counted from the north point by A, the reading of the horizontal circle by R, the latitude by θ, the declination of the star by δ, and the observed altitude by h. Use the subscripts e and w for east and west of the meridian. The formulas are

$$A_e - A_w = R_e - R_w$$

$$\sin \tfrac{1}{2}(A_e + A_w) = \frac{-\cos \tfrac{1}{2}(\delta_e + \delta_w) \sin \tfrac{1}{2}(\delta_e - \delta_w)}{\cos \theta \cos h \sin \tfrac{1}{2}(A_e - A_w)}$$

$$A_e = \tfrac{1}{2}(A_e + A_w) + \tfrac{1}{2}(A_e - A_w)$$

$$R \text{ (north point)} = R_e - A_e$$

It will be noticed that the correction, $\frac{1}{2}(A_e + A_w)$, is zero for stars of the same declination, and approaches zero with $(\delta_e - \delta_w)$. As a test of the method, Mizar (in the Dipper) was observed at the same altitude as α Cassiopeiae on the evening of July 29, 1932. Two settings differing by one revolution of the gradienter screw were made on each star. Three readings were made on Polaris in the usual way. The R (north point) obtained from Mizar and α Cassiopeiae differed by 11 sec. from that obtained by the standard Polaris method.

The writer will be glad to hear of engineers who have given the method a trial.

C. C. WYLIE,
Associate Professor in Astronomy, University of Iowa.

Iowa City, Iowa, Aug. 3, 1932.

Early Days on the St. Lawrence

Sir—Your July 21 issue has a good deal about the St. Lawrence River development which brings that river back to my memory.

These great works move slowly; in 1872 and 1873 I was assistant engineer on some surveys of the river. John Page was the chief engineer of the Department of Public Works (Canada) and undertook surveys to determine the possibility of increasing the capacity of the canals to a depth of 13 or perhaps 15 ft. on the miter sills of the locks which had then a depth of 9 ft. Tom S. Rubidge was in charge of the surveys of the upper canals. There were four of them: Les Galops Rapide du Plat, Farrans Point and the Long Sault, which ran into Lake St. Francis at Cornwall. I was assistant to Mr. Rubidge. We had a small steamboat, the "Lorena," of which I had direct charge, and a field party for work on shore.

The first work undertaken was sweeping the reaches of the river between the canals. We had a pole about 6x6 in. set through an iron frame at each end of the Lorena's bridge. This pole had a curved iron at its foot, to ride over any rough place in the bottom, and it was set to a depth of 15 ft. below water. One pole at each end of the bridge was used. While operating, a man stood with one foot on the clamp and could feel anything the iron struck. We would make as many runs down as necessary to cover the river, also taking soundings with a lead line as we went.

During the winter I was sent to Lake St. Francis and took soundings through the ice, which was 2 ft. thick and more also surveyed the islands in the lake, which was too wide and had too many islands to survey with our boat.

We also made surveys of the canals, setting up a parallel to the original center line on the tow path. The canals were located with a compass, cross-sections were taken where needed and were called "stations." Thus station 3 to station 4 might be 25 ft., and station 4 to station 5, 170 ft. The curves were run of such and such a radius, and deflections were figured to fit.

After we finished our survey, we were to survey the Thousand Islands, but there was an election, Sir John A. Macdonald was defeated, and, as we had been employed under the defeated party, we were promptly fired; so I stayed fired.

C. D. PURDON.

St. Louis, Mo.
July 27, 1932.

EDITOR'S NOTE—The reader will be interested to know that Mr. Purdon was formerly chief engineer of the St. Louis-Southwestern Railway and the line's consulting engineer until the time of his retirement in 1930. Previously he was assistant chief engineer of the Atchison, Topeka and Santa Fe, then chief engineer of the St. Louis-San Francisco Railway.

Unsymmetrical Street Crowns

Sir—The discussion by Prof. R. B. Kittredge of the subject of unsymmetrical street crowns (*ENR*, June 30, p. 927) with reference to my article published May 5, 1932, p. 656, is commendable. The conclusion reached by Professor Kittredge, from the mathematical proof given, is stated at the close of the second paragraph in a congruous manner. This conclusion is identical in scope with that of the original article. My contention is, however, that the work can be simplified by revising or extending the equation:

$$W_1 = W - 2W_2$$

Using Mr. Humphrey's notation and equation (5), p. 557 of my article, and with the hypothesis in mind, the above equation may be written:

$$2W_2 + \frac{D}{S} = W$$

Assume W_2 and solve for D. The values H_1 and H_2 are fixed, and their amounts are self-evident. W_1 is unnecessary because such a distance is of little use in practice. Furthermore, the figure given at the top of p. 927 is misleading, because in a general case W_1 is not equal to $\frac{1}{2} W$. The proof given, however, suffices for any condition.

M. W. FURR,
Professor of Civil Engineering, Kansas State College.

Manhattan, Kan.,
Aug. 26, 1932.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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SEPTEMBER 8, 1932 Volume 109 Number 10

Getting the Facts

NEW TYPES of armament for the attack on the practical problems of earthquake protection are being put into service, as Commander Heck recounts on another page. With this move we are at least approaching the objective of getting measured facts on those occurrences that do the real damage in seismic phenomena. Until now the effort has been to study earthquakes at long range, measuring the tiny vibrations that are transmitted around and through the more or less solid ball of the earth; but, however important may have been the scientific results of these efforts, they gave the engineer little or no help in making houses, bridges and water reservoirs proof against destruction. There is excellent reason for believing that they can be made earthquake-proof, but this result will never be achieved until the forces and motions to be resisted are known in definite terms. If the campaign to acquire the needed data is not throttled by the present-day shouters against governmental expenditure, we may look forward to results, perhaps slow to accumulate but certain in the end.

Research, Not Routine

GREAT research institutions such as that just opened at Berkeley serve a vastly important function in advancing the engineering sciences, and it is one of the hopeful facts of modern times that such institutions are available in every part of the country. Knowledge respecting the behavior of materials, structures and machines, excellent though it be, is constantly being outstripped by the demands of practice, and unsolved problems that call for fundamental study accumulate even more. It is in the great modern research centers at the large technical colleges that these problems will largely be solved. The strongest reasons, therefore, speak in favor of intensive devotion to pure research at these laboratories. Where their work is forced into routine testing, or other less worthy activities, the research spirit is throttled, and at the same time the institution takes on the unworthy role of competing with well-established commercial testing organizations, to the detriment of a service constantly needed by the construction industry. Let research at the college laboratories be encouraged to fullest extent, but let it be kept clear of commercial admixture.

Better Than Calculation

AS AN EXAMPLE of a situation where study of a model brings quicker and fuller insight into structural behavior than analysis by calculation, the work done on the proposed Main Avenue arch at Cleveland has much suggestive value. Secondary distortions in particular are susceptible of rapid model study, at least for qualitative and often also for quantitative results. The older rules of bridge design did not countenance the use of structural forms in which large secondary actions or ambiguities of stress were likely, but the practice of recent times has brought frequent occasion for disregarding the rule. For conditions that lead to the design of an incompletely stiffened rib arch, as that of Main Avenue, the probability of special stress complications at the floor intersection is quite apparent, but calculation is rendered uncertain by the assumptions that must be made. Bold solution of the difficulty by testing a model affords a way out, and, while approximation still remains due to the uncertainty of how truly the model reproduces the bridge, the problem is more tangibly grasped. Modern practice is likely to afford an increasing field for the application of such study.

Hold to Standards!

ONE RESULT of the depression that has already been pointed out is the risk of lowered quality of workmanship due to demoralization of the manufacturing personnel. There are numerous reports of difficulty in meeting rather ordinary inspection, and of much non-marketable product. Such experiences point the lesson of holding to quality standards at all costs. No producer can afford to increase his rejections, least of all at times of bedrock prices. Engineers can help to control the evil by more rigid and careful inspection of workmanship; their vigilance to uphold high quality standards will react to the benefit of producer and user alike. A related evil flowing from the depression is the tendency toward breaking down of zoning regulations. This has been serious enough in the Chicago neighborhood to lead the Regional Planning Association of that city to issue a warning bulletin to the municipalities in the region. It calls attention clearly to the fact that there is grave danger of public harm if present economic conditions are allowed to excuse a breaking down of zoning rules. The damage that may result, says the association, affects the whole community permanently and outweighs any temporary benefit that may be gained by a small number of individuals. The warning is of patent force. Standards should be and can be maintained, in zoning as well as in production.

Perennial Charges

CHARGES that labor is being exploited at Hoover Dam may be expected to be perennial. The project is too much in the public eye for labor agitators to fail to grasp every opportunity to get across to the public the idea that the government's refusal to let union labor organizations have full control there has resulted in grave abuses. The latest crop of charges—to the effect that workmen are compelled to accept scrip in payment of wages and thus are forced to trade at the contractor's commissary—is typical of what may be expected. Broadcast by a United States Senator, they obtained wider publicity than their prompt denial and the satisfactory explanation of the use of scrip at the dam. From the outset of the work the Bureau of Reclamation and the contractor, Six Companies, have labored devotedly and effectively to provide the maximum amount of comfort for those who must work and live under the adverse climatic conditions at the Canyon; expense has not been

stinted in providing conveniences far beyond those customary in construction camps. Their reward should be high praise and thanks, instead of malicious charges fostered by labor agitators and by disgruntled merchants and camp followers who see their profits vanishing as Boulder City develops into a contented and self-contained community. It is to be hoped that the Senate committee now studying reclamation projects in California complies with the request of Elwood Mead, head of the engineering forces charged with construction of the dam, that it visit the dam, so that the Senate will have first-hand information as to the groundlessness of charges like those of Senator Oddie.

Continued Delays

NO ACTION to date has yet been reported on a single construction project submitted to the Reconstruction Finance Corporation for a loan under the emergency relief and construction act. Seven weeks have passed since the act was approved, and the unemployment emergency is in no way decreased. With winter coming on, only the most determined and well-planned action can put any large volume of work under way before snow flies, or for that matter make work ready for starting construction next spring.

Circular 3 has been issued by the corporation, as summarized in our news pages last week. Outlining the corporation's requirements for loans, the circular nevertheless leaves wide open the question of what constitutes a self-liquidating project. In this respect it does little more than paraphrase the wording of the relief act itself. Presumably the directors' action upon the projects now before them will in course of time develop a definition of what the corporation considers to be self-liquidating projects. In its present emergency, however, the country should not have to wait on such a slow process. A definite pronouncement would speed the operation of the act.

In view of the obstacles that have beset the corporation and its board since the approval of the act, it is only fair to say that too short a time has yet elapsed to show whether or not the act will be administered in a way to make it effective in reducing unemployment. The next few weeks, however, will tell the story. If they do not result in more concrete action by the directors than has yet been reported, the conclusion will be inescapable that the most significant section of the relief act has been allowed to become a dead letter, for this year at least.

That the applications so far submitted to the board are incomplete is perhaps the primary factor in delaying constructive action. At least some of the responsibility for this condition rests upon the corporation, for in the absence of any instructions as to procedure until the issuance of Circular 3 the applicants were left in the dark concerning the required data and proofs. But even a larger responsibility rests on the communities themselves. Their general failure to take the necessary legal and administrative steps to support an adequate loan application and the unreadiness of their engineering plans and estimates were bound to hamper the operations of the corporation vitally.

Engineering plans and adequate justifying data are costly to prepare. Depleted engineering staffs have also militated against the preparation of thorough plans, with their necessary studies of traffic or consumption and their cost estimates. Present information indicates that, due to such factors as these, relatively few projects the country over can be put in shape for work this winter unless vigorous action is taken in every affected community to speed its planning. Adequately reinforced engineering staffs or the drafting of private engineering service are the necessary means for bringing the work to early completion.

Now that the R.F.C. engineering board is actively at work it may be expected that action at Washington will bring early results on those applications that are perfected and complete. For the rest, the responsibility is on the local communities to act with energy and complete their plans and authorizations for earliest possible action. National as is the emergency of unemployment, the actual burden is local, and each individual community faces the task of providing for its unemployed. The emergency relief and construction act creates an opportunity for putting men to work. It is for the community itself to take advantage of this opportunity by acting with speed in developing its plans.

No Reason for Excitement

CONCERN in the equipment trade over requirements for hand labor in spending the $120,000,000 emergency-loan money for road construction appears in danger of becoming a little hysterical. The conditions are objectionable and represent a reversion to outmoded construction practice, but caution should be exercised not to give them too much importance.

As presented in published texts the requirements for hand labor appear to be more mandatory and inclusive than they are likely to prove in actual practice. Much discretion is left to highway officials in choosing between methods, and most of the operations on which hand labor is specified employ ordinarily very little machinery. Even if drastically enforced, all the hand-labor requirements set forth by the Bureau of Public Roads would put out of commission a very small fraction of the road contractor's normal plant.

Concerted action of the equipment manufacturers, as undertaken in Ohio, in protesting against requirements for hand labor have a salutary purpose in directing attention to retrogressive public-works construction policies. If maintained by presenting factual evidence of the increased cost of hand labor, a positive influence can be exerted that will discourage attempts to perpetuate the practice beyond the justification that wholesale unemployment now offers. Conviction obviously can be carried to the public forcefully only in line with its economic interest; complaint that the manufacturer will lose sales will appeal to unsympathetic ears. On the contrary evidence that by machine construction the taxpayer gets his public improvements sooner and pays less for them and that the spread of labor is greater when the shop laborer and all those behind him are given work may expect an attentive hearing.

Organized equipment interests can perform a needed duty in opposing hand labor, but action should be based on a broader program. The danger lies less in the losses to machine construction during the ten months that the requirements for emergency-loan road construction will be in force than in the habit of employment established and the disposition created to continue it beyond the immediate needs of the present emergency. These possibilities well warrant organized action.

NEWS OF THE WEEK

New Orleans Bridge Expected to Get First R.F.C. Loan

Washington Correspondence

THE BRIDGE of the Public Belt Railroad Commission of New Orleans, to span the Mississippi River 12 miles above that city, is expected to be the recipient of the first self-liquidating loan authorized by the Reconstruction Finance Corporation. The engineering features of this project are stated to be in finished form. When they were first presented there was some discussion in the engineering board as to the feasibility of carrying the foundations of the bridge to a depth of 170 ft. but agreement soon was reached on that question. The project could have been acted upon a week or more earlier had it not been for legal problems involved.

Some 200 applications have impressed the board of engineers as being of sufficient promise to permit of their being given a preferred status. This list includes 26 bridges; 68 water supply systems; 26 power plants; 30 irrigation projects; 4 docks; 4 drainage projects; 9 sewers and 1 hospital.

In a deferred list are more than 200 additional applications covering such projects as street improvement, reforestation, markets, dormitories, terminals, and flood control. One application on file covers a cave, another an aqueduct and still another a ferry boat operation. An application has been filed covering the Florida ship canal. Notice has been given that formal application will be submitted shortly covering the 38th Street tunnel project at New York. What is believed to be all the engineering data necessary in connection with the Triborough bridge at New York has been submitted.

Very serious consideration is being given the problems involved in slum clearance. A difficulty that has been encountered in that connection is the securing at reasonable prices of a large area comprised of many parcels of land in separate ownership. To be economical such a project must be a large-scale operation covering considerable area.

As a result of the issuance of Circular No. 3 setting forth the exact information required, the engineering board, at this time, is being swamped with a large number of revised applications.

Large New Hospital Group Opened in New York

A remarkably complete and extensive hospital plant was placed at the disposal of residents of New York City on Sept. 1 when the new group of buildings of the New York Hospital-Cornell Medical College was opened. Occupying three city blocks between 68th and 71st Sts. along the East River, the group includes eleven buildings with a gross floor area of 1,963,700 sq.ft. and a volume of 28¼ million cubic feet. Accommodations are provided for 1,000 bed patients and 1,000 out patients, as well as quarters for 125 resident doctors and 500 nurses and facilities for 300 medical students of Cornell University. New York Hospital, granted its charter in 1771, is the second oldest hospital in the United States, exceeded in years of service only by the Pennsylvania Hospital in Philadelphia. The Cornell Medical school has been affiliated with the hospital for many years. The new plant was planned and built for a service life of 100 years.

In the center of the group, rising high above the other buildings is a single structure, twenty-seven stories high, containing three separate units. The lower nine floors constitute the general hospital for medical and surgical patients. Superimposed on this are two other buildings. The first, of six stories, is for private patients and the second, at the top, contains the living quarters for the resident staff. Floors 10 and 11 are devoted to operating rooms accessible from the general hospital below and the private patient hospital above. On each of the first nine floors, at the end of the two southern wings is a large sun room

(Continued on p. 301)

Sudden Flood Delays Work on Hoover Dam Tunnels

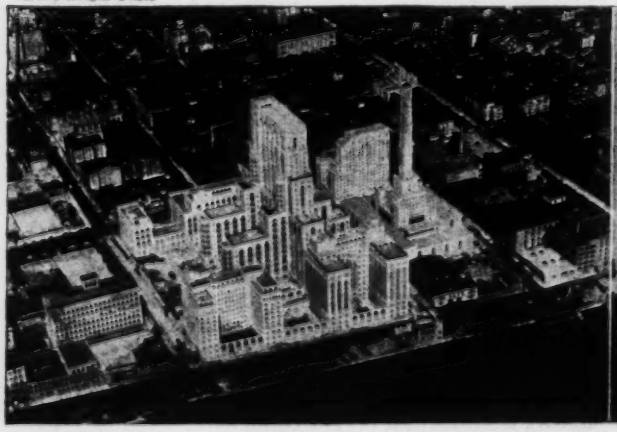
Damage resulting to work at the Hoover Dam caused by the unexpected flood in the Colorado River last week was small, it is stated by Elwood Mead, Commissioner of Reclamation. •Cofferdams were in progress of removal from the inlet and outlet ends of the tunnels so that better ventilation could be secured. As a result there was little protection when the discharge of the Colorado River increased from less than 7,000 to nearly 50,000 sec.-ft. Silt and debris had been removed sufficiently from the tunnels Sept. 3 so as to permit the resumption of work. Practically all of the damage was at the inlet ends of the tunnels, little water entering at the outlet ends. The principal loss was in the delay and the pumping cost.

Cave-in Kills Five in Tunnel of Hetch Hetchy Water Project

A tunnel cave-in during retimbering operations killed five men in the Coast Range tunnels of the San Francisco Hetch Hetchy water supply system on Aug. 28. The accident happened to a crew of sixteen at work on replacing and strengthening timbering in a completed section of the tunnel prior to concrete lining operations. Exact cause of the accident probably never will be known. The crew was composed of experienced miners and timbermen. During the replacing of some of the sets, the five men were working on and under a temporary staging when the roof and walls collapsed. Surviving members of the crew separated by the cave-in reached the surface by way of the shafts at either end of the section but later returned with the rescue parties. The bodies were recovered within a day and work was resumed. The accident did not delay general progress on the work. The verdict of the coroner's jury was "unavoidable accident."

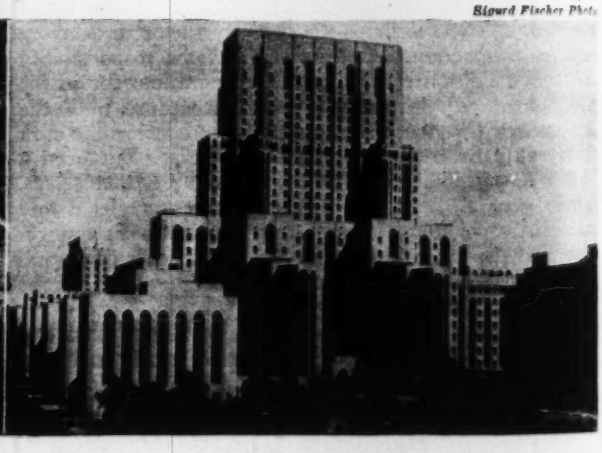
New York Hospital-Cornell Medical College group of buildings occupies 3 blocks along East River in New York City. This view is taken from over the river.

Curtiss-Wright Photo



Main building with a semi-circular solarium at the south end of every hospital floor. Four low buildings at left are to house the Cornell Medical College.

Sigurd Fischer Photo



Los Angeles Water District Plans for Aqueduct Construction

Adoption of a tax levy of four cents per $100 assessed valuation for the fiscal year ending next June has been voted by directors of the Metropolitan Water District of Southern California. The levy is expected to net the district about $700,000 which is expected to carry on the district activities on about the scale of the past year. About 75 per cent of the income will be expended for labor, the overhead having been reduced to a minimum. The work planned will be directed toward preparing the way for the Colorado River aqueduct construction, which work is to be started when income is available either from bonds or an R.F.C. loan.

Directors of the district also adopted a resolution authorizing the opening of negotiations with the city of Pasadena, Calif., on the proposed use by the district of Pasadena's Pine Canyon reservoir.

Diversion of Highway Funds in Oklahoma Proposed

A bill to ask that more than $8,000,000 be diverted from the highway funds to help pay off state indebtedness will be proposed to the Oklahoma legislature by Senator E. M. Reed, according to announcement published recently. He will ask that the entire revenue from license tags, amounting to nearly $5,500,000 yearly, and 2 cents of the 4-cent state gas tax be used in wiping out state debts instead of building roads and maintaining highways.

"All this gasoline money goes into the highway funds; what we have got to do for two or three years is to stop building roads. Its more important to put the state on a sound financial basis than to keep spending money we haven't got on new highways," Senator Reed said.

The proposal would not in any way interfere with the $7,000,000 road building program which will be launched soon.

First Vertical-Lift Bridge in Great Britain Being Built

The new bridge between Middlesbrough and Durham, England, known as the Tees (Newport) bridge is notable for being the first vertical-lift structure in Great Britain and for containing a five-span welded bridge 218 ft. long in one of its approaches. According to an article in *The Surveyor* for July 15, 1932, the bridge supplements a toll transporter bridge on which all traffic, passenger and vehicular, is carried across the river by a moving car. The lift span is 270 ft. long, suspended at both ends from towers 170 ft. high. It provides a vertical clearance of 120 ft. In the Durham approach the rail lines of the London & Northeastern Railway are crossed by a five-span steel bridge 218 ft. long of welded construction. The roadway width of the bridge is 38 ft. Substructure work is well advanced, and erection of the towers for the vertical-lift span is now under way. The bridge is being built by a joint committee of the Middlesbrough Corp. and the Durham County Council. The engineers responsible for the design and erection are Mott, Hay and Anderson, of Westminster. Dorman, Long & Co., Ltd., is the contractor.

New Engineering Courses at New York University

Plans of considerable magnitude for work along sanitary engineering lines will be started at New York University with the opening of the present college year on Sept. 19. Thorndike Saville, professor of hydraulic and sanitary engineering at the University of North Carolina has accepted an offer from New York University to take charge of this important field as a new department in the College of Engineering.

Arrangements have been made with the graduate school of New York University whereby the degree of M. S. will be granted for post graduate work in sanitary engineering. This work will consist of major courses offered in the new department of sanitary engineering together with courses already established in the Graduate School.

These courses will be inaugurated during the coming year of 1932-33 and a few specially qualified men will be accepted. It is believed that the initial work can be adapted to the qualifications of the student to greater advantage than by setting up a definite curriculum, certainly during the first year.

It is planned for another year to have a "sanitary option" in the senior year for undergraduate students in civil engineering whereby certain more or less specialized courses in other fields will be replaced by courses in hydraulic and sanitary Engineering.

It is believed by the university authorities that the future demands for highly specialized training in hydraulic and sanitary engineering justify the establshment of specialized facilities, for graduate study and research, particularly in the great metropolitan center of New York.

Professor Saville from 1907 to 1910 was a resident of the Canal Zone where he became familiar with all types of work there. Following two years of service as a first lieutenant in the United States Army, during which he was in charge of design and construction of important water supply and sewage treatment works, he was appointed Sheldon Travelling Fellow from Harvard University in 1919, visiting England and France to investigate river regulation and sewage treatment processes. In 1926-27 he was consultng engineer to the government of Venezuela on water supply for Caracas. In 1929 he was consultant to the Board on Beach Erosion, U. S. Army Engineers, and in 1930 he was made a member of the board. Since 1920 he has been chief engineer of the North Carolina Geological Survey and its successor, the North Carolina Department of Conservation and Development, in charge of the Water Resources Division. He became a member of the University of North Carolina faculty in 1919.

Contract for Purification Plant for Toronto, Ontario, Let

The contract for the construction of the water purification plant in Victoria Park, Toronto, Ont., has been awarded to the Northern Construction Company and J. W. Stewart, Ltd., at a price of $1,056,000. The filtration plant is part of a huge project which will give the city of Toronto a duplicate water system. Consulting engineers on the development are Gore, Nasmith and Storrie, Toronto, and H. G. Acres and Company, Niagara Falls, Ontario.

NEW RAIL-BARGE TERMINAL ON THE OHIO RIVER

A terminal for the transfer of coal from barges on the Ohio river to railroad cars was put into service by the Pittsburgh & Lake Erie R.R. recently at Colona, Pa., 23 miles west of Pittsburgh. It is located in a natural harbor where barges unload without interfering with the channel. The main hoisting tower and bridge are stationary. Barges are brought alongside the timber breastwork and attached to a shifter which moves them along at a rate of 75 ft. per minute. The clamshell bucket of the hoist takes 9 tons as a load, travels at a rate of 400 ft. per minute and makes a complete hoisting cycle in 36 seconds giving a capacity of 500 tons per hour. The rail yard has a capacity of 52 loaded cars and 52 empties.

Wholesale Water Rate Reduced In St. Louis Suburb

As the result of a conference between the Webster Groves (Mo.) city council and the St. Louis County Water Co., the wholesale price of water, as purchased by the city from the company, was reduced from 17c. per 1,000 gal. to 13½c. If approved by the state public service commission the new rate will go into effect Sept. 1.

The new offer was made after the council had advertised for bids for the construction of a separate water plant for the city. Webster Groves owns its distribution system. The mayor has stated that consideration would now be given to a reduction in the retail water rate.

Construction of a Public Market at New Orleans Proposed

Construction of a new public market and farmers terminal on the site of the present obsolete French Market has been made possible as a result of sale of a franchise and leasehold by the commission council to the French Market Corporation. The cost of the projected improvements is estimated at $700,000. The corporation is composed of property owners and business operators in the French Market section, the object of the move being the enlargement and perpetuation of the commercial center there.

The construction of the market will involve the demolishing of the old structure, which has been a landmark for several generations, and of several additional structures. A factor in the demolition of the buildings is the necessity of moving the levee back because of undermining of the river bank at that point. Because of the necessity of taking over highly improved property, the Orleans Levee Board will pay $200,000 into the project and in return will secure needed right of way on North and Peters Sts. The city will put up $200,000 from the special fund raised by a bond issue for rehabilitation of the public market system. The balance, $300,000 will be raised by sale of bonds by the corporation.

The buildings to be erected are estimated to cost $266,889 and equipment $25,000.

A.G.C. To Push Relief Work

Intensification of the drive of the construction industry to have the country take full advantage of the provisions of the Emergency Relief and Construction Act is to be one of the major objectives of the fall meetings of the executive cabinet and advisory boards of the Associated General Contractors of America to be held in Washington Oct. 9-11. These meetings will precede those of the policy committee of the Construction League of the United States, to be held on Oct. 12 and the general assembly of the National Conference on Construction to be held in Washington Oct. 13-14.

Subjects Announced for Meeting of Public Works Officials

The subjects scheduled for discussion at the meeting of the International Association of Public Works Officials to be held in Pittsburgh September 29-October 1 are as follows: Efficiency of street cleaning and its relation to reduced budgets; modern methods of garbage collection; incinerator location; long-range planning of public works; the economic readjustment and its relation to the public works officials; sewage disposal; sewer maintenance; dust prevention on dirt streets; and management and care of municipal equipment.

New Director of Engineering for Carnegie Institute of Technology

Webster N. Jones, general superintendent of the processing division, The B. F. Goodrich Co., Akron, Ohio, resigned that position on Aug. 1, to become director of engineering of Carnegie Institute of Technology at Pittsburgh. Dr. Jones was born at Rich Hill, Missouri, is a graduate of the University of Missouri, and completed his graduate study at Harvard. In engaging in educational work, he returns to a field in which he has spent ten years of his career, teaching at Purdue Universtiy in 1910, Harvard University, 1911, University of Maine, 1912, University of Missouri, 1913, and University of Montana, 1915-18.

NEW CIMARRON RIVER BRIDGE NEAR GUTHRIE, OKLA.

The new Cimarron River crossing 2 miles north of Guthrie, Okla., consists of eleven 83-ft. steel plate-girder spans carrying a 25 ft.-wide reinforced concrete roadway. Abutments are carried on wood piles while the ten piers were sunk 25 ft. through quicksand in open steel pile cofferdams. The bridge was built on a dry river bottom and completed and opened to traffic one day prior to a flood, which had been expected. Since completion of the bridge Nov. 15, 1931, the river bed has not been unwatered. The cost of the bridge was $125,000. It was built under the supervision of C. W. McFarron, state highway engineer of Oklahoma, by Woods Bros. Corp., Lincoln, Nebr., for whom Sutton Van Pelt was superintendent during construction.

Changes in Engineering School at University of Washington

Under the reorganization of the University of Washington made effective in July by the Board of Regents of the state, the number of colleges in the university is reduced from 13 to 4. The four new units are the college of arts and sciences, the college of technology, the school of law, and the graduate school. The college of technology includes the former colleges of engineering, forestry, mines, and pharmacy.

R. G. Tyler, dean of the former college of engineering, states that an attempt is being made to organize the college of technology into a lower and upper division and to make the lower division terminal for students whose qualifications lean more toward sub-professional than toward strictly professional lines of work.

Road Bonds To Be Considered by Texas Legislature

The state legislature of Texas was called into special session on Aug. 30. Among the subjects to be considered is the assumption out of gasoline tax revenues of the payment of county and district bond issues which have been applied to the construction of state highways. Another subject for legislative action is the passage of a law permitting building and loan associations and insurance companies to become members of the federal home loan bank system in order to facilitate house construction in the state.

The amount of the outstanding indebtedness of county and road districts in the state is not known but it is estimated to be between 90 and 100 million dollars. To pay off the bonds as they become due and to meet interest charges will require about $7,000,000 which sum is to be obtained by setting aside one cent of the four-cent gasoline tax, according to the plan proposed by Governor Sterling.

Philadelphia Survey Shows Many Civil Engineers Unemployed

A survey recently completed by the Philadelphia Technical Service Committee shows that the larger number of engineers out of employment are in the civil and mechanical engineering groups.

Nearly 1,000 engineers have registered with the committee since it was organized several weeks ago. An analysis of the applications shows the following classifications: architectural, 15; chemical, 88; civil, 214; electrical, 182; structural, 48; industrial, 10; mechanical, 355; mining and metallurgical, 20; miscellaneous, 14. The industrial nature of the Philadelphia industries is responsible for the large number of mechanical engineers registered.

An analysis of the salaries heretofore received by the applicants shows that 48 per cent of all the men registered received $2,500 a year or less, 29 per cent received between $2,500 and $3,500, 17 per cent received between $3,500 and $5,000 and only 6 per cent received over $5,000 a year.

Thirty-five per cent of the men are under 30 years of age, 34 per cent are between 30 and 40, 24 per cent between 40 and 50, and 7 per cent are over 50 years of age.

Start of Mono Basin Project Proposed for Relief Work

The Los Angeles Water and Power Commission has been urged by Mayor John C. Porter to take every possible step for the early start of construction work upon the city's Mono basin water project, to the end that employment might be furnished hundreds of men for a period of several years. Mayor Porter pointed out that the Mono basin project, which will increase the city's water supply by approximately thirty-three per cent, was voted by the people in a bond issue more than two years ago, and that all preliminary engineering work was completed more than a year ago. The Water and Power Commission is now negotiating with the Southern Sierras Power Company and all other Mono basin property owners for acquisition of water rights and lands. The Mono basin is on the east side of the Sierra Nevada range and north of Owens Valley, the city's present major source of water supply.

New Hospital Group Opened in New York

(*Continued from p. 298*)

semi-circular in plan. Similar sun rooms, although smaller, adjoin each floor of the private patients' section above.

To the east of this central building, adjoining it and fronting on the East River, are two buildings, the Women's Clinic (at the right in the air view) and the Children's Clinic. To the east and south, connected to the other buildings by tunnels, is the Psychiatric Clinic, a U-shaped structure also fronting on the East River.

Adjoining the general hospital on the west is the Cornell University Medical College, a building of seven stories with four wings fronting on the street that bounds the site on the west. Each floor of the school building is connected to the main hospital. Across 70th St. to the north are the Nurses' Residence, a building of 16 stories, and a large service building which includes power plant, garage and laundry.

Among the outstanding features of the hospital is the extensive use of the many roofs provided by the low wings. The roof area used by the patients is set back some 6 ft. from the parapet walls and raised 2 or 3 ft. above them, permitting the use of open railings which do not obstruct the view and at the same time afford ample safety.

The service buildings contain one of the largest private power plants in the city, a parking garage for 250 automobiles, and facilities for housing 200 employees of the hospital. The smokestack of the power plant, 14 ft. in diameter, 405 ft. high, is carried within a structural steel frame in turn encased in brick. In the design of the structural steel frame, some 20 ft. square and 400 ft. high, carried out by Purdy & Henderson the consulting engineers, Spurr's theory of wind design based on a limiting allowable deflection was given its first complete test. It had been used previously on the Manhattan Co. building but the complicated framework of this structure was not conducive to strict application.

Golden Gate Bridge to Be Started Within 90 Days

ACCEPTANCE of a local syndicate bid for the first $6,000,000 block of bonds for the Golden Gate bridge was followed by an announcement of the board of directors that work on the project will begin within 90 days and the application for a $35,000,000 R.F.C. loan will be withdrawn. The accepted bid, one of three, was for $5,538,000. An immediate advance of $200,000 from the bank syndicate to the district for current expenses permits the elimination of a 2½c. assessment from the tax rolls of the several counties in the district. No option for the remaining $29,000,000 of the bond issue was carried in the accepted bid.

The call for bids on the block of bonds followed announcement that principals in the opposition suit in federal court waived right to appeal the district court decision which upheld the district organization and taxing power. Several weeks remain of the 90-day period for appeal but the stipulation of waiver by the leading opponents indicates there will be no extension of the litigation.

On Aug. 18 the directors of the district voted to extend for six months the $10,000,000 contract awarded more than a year ago to the McClintic-Marshall Co. for steel superstructure. The other contracts according to reports, with the exception of the award on the foundation work, can also be extended on the former price basis.

Additional States Set Wage Rates for Highway Relief Work

Minimum wage rates for highway construction work under the provisions of the emergency relief act, in addition to those previously reported, have been set by announcement of several state highway departments. In Massachusetts the Department of Public Works set a minimum rate of 45 cents per hour for unskilled labor and 55 cents for skilled labor.

In Florida the state road department has set a minimum rate of 20 cents an hour for unskilled labor. This is stated to be substantially more than the rate now paid in some parts of the state.

The State Highway Commission of North Carolina, in its current notices to contractors calling for bids on highway construction, sets a minimum wage scale for unskilled labor of 20 cents per hour and for skilled labor of 30 cents per hour. No reference is made to the 30-hour week requirement of the relief act.

Wyoming has set a minimum wage of 50 cents per hour for unskilled and 60 cents for skilled labor and has limited working hours to 30 per week and 8 per day for any one workman. A maximum charge of 75c. per day for board and lodging has been set.

Minimum rates have been set by the Montana highway commission as follows: steam shovel runner, and dragline operators $1.00; chief mechanics, 87½c.; carpenters, blacksmiths, finishers, grader men (12-ft. and above) 75c.; truck drivers (less than 2-ton), teamsters, fresno men and unskilled labor 50c. Camp charges must not exceed $1.00 per day.

Floods Wash Out Spans of International Bridge

Two spans of the international railroad bridge across the Rio Grande at Laredo, Texas, are reported to have been washed out on Sept. 3 in a flood which has caused wide devastation in the Rio Grande valley in the past weeks. Several railroad employees are believed to have lost their lives when the bridge collapsed. The spans that were lost were at the Mexican side of the river.

San Francisco Votes Relief Bond Issue of $6,500,000

By a 7 to 1 majority, San Francisco voted a $6,500,000 relief bond issue Aug. 30 to care for distress among its citizens. Passage of the bond measure assured against a material increase in the tax rate during the ensuing year to provide the same relief. The issue had the support of the administration and all civic bodies as the most logical method of providing the necessary food and shelter, and will be administered by a citizens committee. Passage of the bond issue, according to reports, assures a tax rate of $4.00 for the city and county of San Francisco for the coming year.

Labor Abuse on Mississippi Work Charged in New Accusations

Charges that labor on the Mississippi flood control work is being exploited by the contractors, underpaid and brutally treated, have been made public by the National Association for the Advancement of the Colored People. The charges are just as vague as those made by the American Federation of Labor last year, charges that after a thorough investigation by the War Department only resulted in the finding of a few isolated cases of brutality which in no way justified the wholesale attack on the contractors on the levee work.

Further investigations of labor conditions have been ordered by the Chief of Engineers, U. S. Army, as a result of these charges. The War Department has pointed out that the nature of the accusation makes it difficult to trace the source of trouble and correct abuses, if they are found to exist.

Engineers of Water Commission Laid Off in Economy Move

Eight members of the staff of the State Water Policy Commission of New Jersey, including all the engineers of the staff, were ordered laid off on Sept. 15 by Governor Moore under the broad powers granted to him by the emergency act of the recent legislature. If the emergency act is not re-enacted at the next session of the legislature the employees will be reinstated automatically on July 1, 1933. The engineers laid off include Morris R. Sherrard, chief engineer and A. C. Sherman, deputy chief engineer.

The Water Policy Commission was appointed in 1929 to determine the state's future needs for water supply and to provide for the acquisition of watersheds required for future use. In 1930 a bond issue of $7,500,000 was approved for the latter purpose but no purchases by the Commission have been authorized.

Personal Notes

EMERY S. LAND, Captain U. S. Navy, has been selected to be Chief of the Bureau of Construction and Repair of the Navy Department, with the rank of rear-admiral. He will take up his new duties October 1. Captain Land will succeed Rear-Admiral George R. Rock, who has reached retirement age.

AUGUST A. FISHER, vice-president, Henry Bickel Co., CHARLES E. CANNELL, president, Cannell-Conrad Construction Co., and GEORGE M. EADY, president, George M. Eady Co., all of Louisville, Ky., have formed a new company, Louisville Constructors, Inc.

HARRY N. JENKS, consulting engineer, Berkeley, Calif., has been appointed professor of hydraulic and sanitary engineering, University of North Carolina, Chapel Hill, N. C., to succeed THORNDIKE SAVILLE, who had been appointed head of the newly organized Department of Sanitary Engineering at New York University. Professor Jenks is a graduate of the University of California in the class of 1916 and has been engaged in sanitary engineering work here and abroad since graduation. At one time he served as associate professor of sanitary engineering at Iowa State College.

Obituary

BERTRAM I. HALL, engineer, New York State Highway Department, died suddenly in Buffalo, N. Y., on August 30. He was 51 years of age. Mr. Hall was born in Boston, and received his engineering education there. After graduation he worked on the New York State Barge Canal. Since 1922 he had been in the highway department.

EARLE C. WIGHT, formerly an engineer of the Denver & Rio Grande, the Southern Pacific, and the Baltimore & Ohio railroads and more recently assistant general freight agent of the latter road, died at his home in Baltimore on Sept. 2, at the age of 49. In addition to his railroad work, Mr. Wight was for a time with the U. S. Geological Survey, and with the Alabama State Highway Commission.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual convention, Washington, D. C., Sept. 26-28.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, White Sulphur Springs, W. Va., Oct. 13-14 (tentative).

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Atlantic City, N. J., Oct. 5-8.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, New Orleans, La., Nov. 14-18.

AMERICAN WELDING SOCIETY, fall meeting, Oct. 3-7, Buffalo, N. Y.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, New York City, Sept. 29-Oct. 1.

NATIONAL SAFETY COUNCIL, annual congress, Washington, D. C., Oct. 3-7.

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

NEW YORK STATE WATERWAYS ASSOCIATION will hold its annual convention at Buffalo, N. Y., September 9-20. Subject for discussion will be the proposed St. Lawrence waterway and the Wagner-Gavagan bill providing federal aid for the New York State Barge Canal without the state surrendering title to the canal.

Engineering Contracts and Capital

Heavy engineering construction contracts reported for the past week total $14,159,000, a decrease from the average of the previous two weeks and more than $4,000,000 below the August weekly average of $20,351,000. Federal awards amounted to only $2,025,000 which is lower than any other week except that ending Aug. 18. Private construction totaled $2,791,000, an increase over the previous week but below the 3rd-quarter average. Large contracts let during the week include state highway contracts in New York totaling more than $4,500,000 and in Kentucky exceeding $900,000.

New capital is up. Large issues responsible for this increase are Golden Gate Bond issue $6,000,000, State of Maine highway and bridge bonds $1,500,000, St. Louis County, Mo., road bonds $1,000,000, Springfield, Ill., water bonds $1,500,000.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Average Sept. 1931	Weekly Average Sept. 1932	Week Sept. 8, 1932
Federal government	$10,409	$3,314	$2,025
State and municipal	21,880	10,696	9,443
Total public	$32,289	$14,010	$11,468
Total private	11,950	2,149	2,791
Week's total	$44,239	$16,158	$14,259

Cumulative, Jan. 1 to date:

1931 construction	$1,858,940
1932	832,524

Decrease, 55 per cent.

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly Average Sept. 1931	Weekly Average Aug. 1932	Week Sept. 3 1932
Total private and public	$45,500	$19,000	$

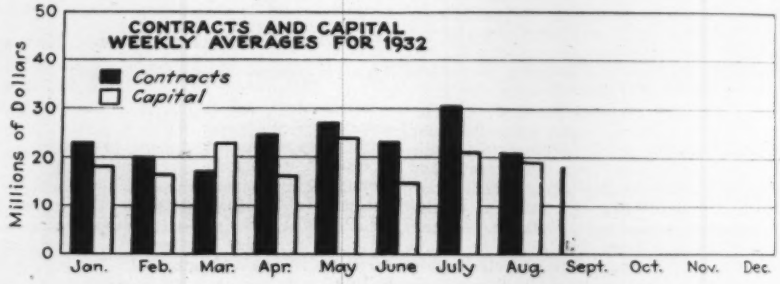
Cumulative, Jan. 1 to date:

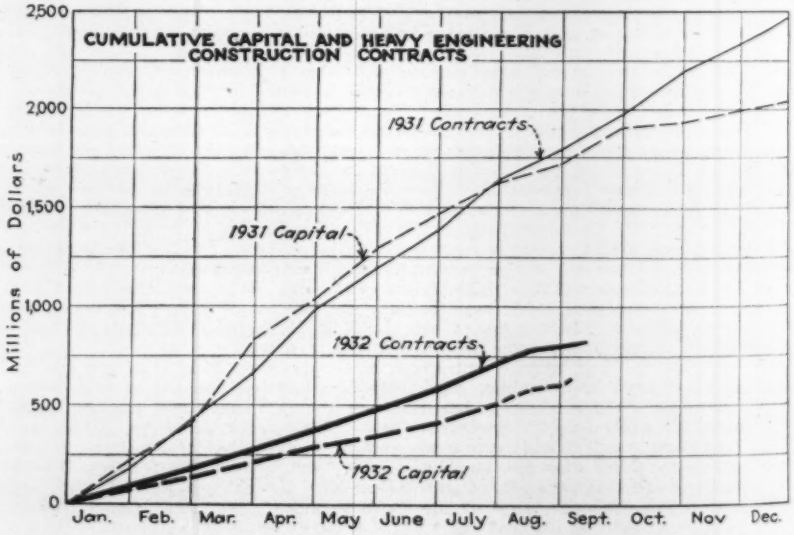
1931 new capital	$1,760,500
1932 new capital	615,808

Decrease 65 per cent.

ENR Cost and Volume Index

Cost		Volume	
September, 1932	157.96	**August, 1932**	111
August, 1932	156.80	July, 1932	166
September, 1931	171.40	August, 1932	187
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average		100.00	





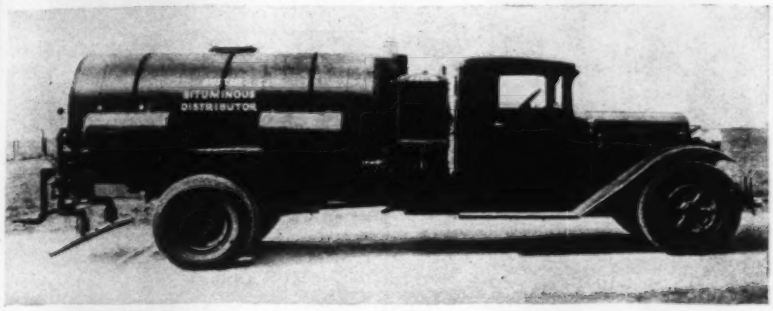
Construction Equipment and Materials

Distributor for Bituminous Materials

A newly developed line of Austin Bituminous Distributors has just been announced by the Austin Western Road Machinery Co., 400 N. Michigan Ave., Chicago, Ill. The units are built in capacities of 600, 800, 1,000, 1,200 and 1,500 gal. to handle all grades of oil, tar and asphalt. They can be mounted on any standard truck chassis.

The tank is elliptical in shape to provide a low center of gravity, and provides an expansion zone. All seams are electrically welded and tested under pressure for water tightness. Provision for heating includes two double U-tube flues with burners that operate on kerosene or light furnace oil. Fuel storage and air pressure tanks have sufficient capacity for a day's run.

The pump is of the internal-gear type, driven by a 4-cylinder motor, and has a capacity of 350 gal. per minute. The motor is placed at the front of the distributor to eliminate fire hazard. Spray bars, or manifolds of welded sheet metal construction, are tapered toward the ends to correspond with the reduction in volume of flow.

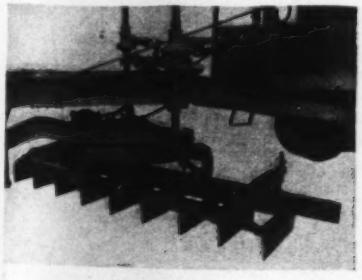


Austin Western Bituminous Distributor

Multiblade Grader for Road Work

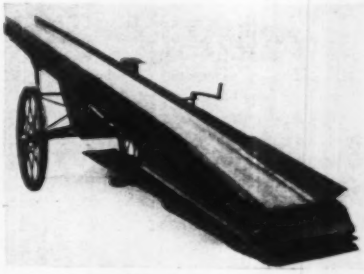
A multiple blade attachment which will cover a swath as wide as that obtained by the use of a standard 12-ft. leveling blade to be installed on auto patrols has been introduced by the Caterpillar Tractor Co., Peoria, Ill. The attachment consists of 9 short cutting blades, 8 in. high, ½ in. thick and 27 in. long, mounted on a frame at right angles to a leveling blade, 12 ft. long. When in operating position the attachment is angled slightly to the right or left. It is given just enough angle to make the path of each blade meet the path of the succeeding one. The long rear blade is adjustable and is placed at a level that is high enough to trowel the surface material back in place over the entire swath. The manufacturer states that the new machine can be operated at a speed of 6½ or even 10 mi. per hr. without chatter. It can be attached in the field to a Caterpillar auto patrol by cutting out two rivets and replacing with bolts.

New road grader capable of high speed without chatter.



Portable Belt Conveyor

A new portable troughed belt conveyor is announced by the Fairfield Engineering Co., Marion, Ohio. The new conveyor is built in lengths of 20, 25 and 30 ft. It is primarily intended for the handling of sand, gravel, crushed stone and other abrasive materials by contractors in material supply yards, sand and gravel pits, stone quarries, industrial plants, and for handling materials for highway maintenance. The conveyor belt is of rubber, 18 in. wide. Power is furnished by a 3-hp. ball-bearing electric motor or a 4½-hp. gasoline engine. A steel-plate receiving hopper at the foot end serves to center the load onto the conveyor belt.



New conveyor by Fairfield.

New Publications

Explosives—The use of explosives in forest and construction work during dry periods is explained in a 16-page pamphlet recently published and made available by the Atlas Powder Co., Wilmington, Del. The book contains instructions and suggestions for the selection and use of explosives to reduce the possibility of starting fires.

Electric Hoists—The Lidgerwood Mfg. Co., Elizabeth, N. J., in its electric hoist catalog No. 100 lists the various types of its motor-driven hoists. The machines described include single-drum hoists, double-drum hoists, three-drum hoists, heavy-duty double-drum hoists, heavy-duty three-drum hoists, electric swinging hoists, boom swinging gear, gear-drive hoists, builders' hoists, drag scraper hoists, capstans and car pullers.

Electric Heating Units—Bulletin No. 270, issued by H. O. Swoboda, Inc., illustrates a type of the "Falcon" bare electric immersion heating unit suitable for large tanks to be used in connection with asphalt, tar, compound, varnish, oil, and similar viscous materials which are electrical insulators. The bulletin gives information on the voltages, capacities and prices of single-phase, two-layer units.

Cast-Iron Pipe—The new "Handbook of deLavaud Centrifugally Cast-Iron Pipe," published by the United States Pipe & Foundry Co., Burlington, N. J., contains revised specifications, together with dimensions and weights of deLavaud pipe in accordance with Federal specification for cast-iron bell-and-spigot water pipe; No. WW-T-421. The company is offering the book for distribution.

Asphalt Surfacing Materials—The Texas Co., Asphalt Dept., New York, N. Y., has published a 28-page booklet describing Texaco Asphalt Road-Surfacing Materials. In addition to describing the characteristics of different types of surfacing materials, macadam binders, surfacing compounds, cut-back asphalt and cold patch, the booklet contains five pages of tables of physical information on asphaltic materials.

New Equipment in Brief

Floor Plate—The Inland Steel Co., Chicago, Ill., has announced the new four-way floor plate. This plate provides matching, traction, draining and ease in sweeping equally in four directions. The projections overlap lengthwise as much as crosswise, so that the plates are equally stiff in both directions. The plate is made in thicknesses from No. 12 gage to 1 in. The pattern is such that each projection exactly centers the next projection at right angles.

Shunt for Blasting Caps—Adoption of a new shunt for enamel wire electric blasting caps is announced by Hercules Powder Co., Wilmington, Del. The new shunt is called the "Wassen" shunt and is made by winding the end wires around a small piece of metal. It is stated that it is as effective as the old type of twisted ends and is easier to untwist and take apart without distorting the wires. For electric caps with plain iron or copper wires, Hercules will continue to use the eyelet shunt.

Business Notes

LAYNE BOWLER, manufacturers of water-system equipment, Memphis, Tenn., have opened up an office at Marshalltown, Ia. G. H. Beard is in charge of the new office.

REVERE COPPER AND BRASS, INC., has opened a sales office in San Francisco at 1615 Russ Building. R. H. Bimms, Jr., Pacific Coast manager, is in charge of the new office. He was formerly assistant sales manager of the Rome Division of Revere.

DRAVO-DOYLE Co. has acquired the sales and engineering business of the Rush Machinery Co. R. M. Rush will continue as manager of the business, which will be conducted as the Rush machinery division of Dravo-Doyle Co. Rush Machinery Co. has been the local distributor for the Iron Fireman Manufacturing Co. in the Pittsburgh district.

Current Construction Unit Prices

Sewers and Appurtenances, Freeport, N. Y.

CONTRACT WAS let in August for the construction of 8-in. sewers and appurtenances in Lateral Sewer Dist. No. 5, Freeport, N. Y. Main items include 96,600 ft. of 8-in. vitrified tile or concrete pipe, 2,100 ft. of 8-in. cast-iron pipe, 290 manholes, 16,000 ft. of 5-in. vitrified tile house laterals and 12,000 ft. of 5-in. cast-iron house laterals. Alternates were received for vitrified or concrete pipe, contract being awarded for vitrified. There were sixteen bids on each alternate received, ranging from $151,151 to $303,550 for the clay pipe and from $155,425 to $310,210 for the concrete pipe. Contract was let to the second low bidder, North Jersey Const. Co., Orange, N. J., for $158,479. This firm's bid for concrete pipe was $163,141.

Following are complete unit prices as submitted by the second, third and fourth low bidders. (A) North Jersey Const. Co., contract; (B) Linus R. Gilbert, Inc., Plainfield, N. J.; (C) Spiniello Constr. Co., Inc., Freeport, N. J. Clyde Potts, New York, is consulting engineer. Baldwin & Cornelius Co., Inc., are village engineers.

	No.	Item	Quantity	Unit Prices (A)	(B)	(C)
Alternate Items	1.	8" vit. tile 0'-6'	3,200	$0.77	$1.10	$0.95
	2.	8" vit. tile 6'-8'	47,200	0.91	1.10	1.15
	3.	8" vit. tile 8'-10'	16,000	0.99	1.20	1.35
	4.	8" vit. tile 10'-12'	100	1.59	2.00	2.75
	5.	8" vit. tile 12'-14'	100	2.00	2.50	3.75
	1A.	8" cem. conc. 0'-6'	3,200	0.84	1.16	1.05
	2A.	8" cem. conc. 6'-8'	47,200	0.98	1.16	1.25
	3A.	8" cem. conc. 8'-10'	16,000	1.06	1.26	1.45
	4A.	8" cem. conc. 10'-12'	100	1.66	2.06	2.85
	5A.	8" cem. conc. 12'-14'	100	2.07	2.56	3.85
	6.	8" cast iron 0'-6'	300	1.49	2.00	1.60
	7.	8" cast iron 6'-8'	900	1.64	2.00	1.70
	8.	8" cast iron 8'-10'	700	1.74	2.20	1.75
	9.	8" cast iron 10'-12'	100	1.84	2.50	3.00
	10.	8" cast iron 12'-14'	100	2.34	2.70	4.00
	11.	Manholes, 0'-8' each	290	62.00	80.00	77.75
	12.	Manholes, 8' to 8"	50	8.00	10.00	5.00
	13.	Manholes, 8' to 12"	10	10.00	15.00	6.00
	14.	Conn. into exist mhs., each	35	20.00	10.00	5.00
	15.	Culvert—Frankel Ave.	1	1,700.00	500.00	1,443.00
	16.	Culvert—So. Brookside Ave.	1	2,000.00	500.00	1,576.00
	17.	Cast iron pipe, tons	5	52.00	60.00	50.00
	18.	5" V.T. house lat. ris. vert.ft	100	0.70	1.00	0.75
	19.	5" V. T. house laterals, lin.ft.	16,000	0.80	0.90	0.60
	20.	5" C. I. house laterals, lin.ft.	12,000	1.09	1.20	0.70
	21.	Lumber, M.b.m	50	55.00	80.00	0.10
	22.	Wood piles, lin.ft	500	0.70	0.01	0.05
	23.	Concrete-A- 1:2:4, cu.yd.	50	12.00	10.00	8.00
	24.	Concrete-B- 1:3:5, cu.yd.	200	10.00	9.00	7.00
	25.	Reinf. steel, lb.	4,000	0.05	0.02	0.025
	26.	Masonry-rock excav., cu.yd.	20	2.00	0.01	0.01
	27.	Additional excav., cu.yd.	400	1.00	2.00	0.75
	28.	Gravel foundation, cu.yd.	500	3.00	1.00	2.00
	29.	Conc. pavem't replac., lin.ft.	2,000	1.50	1.00	1.75
	30.	Conc. pavem't add., sq.ft.	3,000	0.35	0.20	0.70
	31.	Asph. pavem't repl., lin.ft.	12,000	1.00	0.50	1.45
	32.	Asph. pavem't add., sq.ft.	10,000	0.25	0.10	0.35
	33.	Asph. surfacing, tons	120	30.00	5.00	8.00
	34.	Sidewalk repl., lin.ft.	15,000	0.80	1.00	0.80
	35.	Sidewalk addit., sq.ft.	5,000	0.20	0.05	0.20
	36.	Curb replac., lin.ft.	100	1.00	1.00	0.50
	37.	Dust laying material, lb.	50,000	0.0225	0.01	0.025
		Total with vitrified pipe		$158,479*	$167,685	$175,272
		Total with concrete pipe		$163,141	$171,681	$181,932
		Completion date		Dec. 31, 1932	Dec. 31, 1932	Dec. 1, 1932

*Contract.

Steel Gates and Hoist, Brandon Road Dam

STEEL head gates, wheel bearings and gate hoist comprise the major portion of work in the alterations of the gate equipment at Brandon Road dam, Des Plaines River, Joliet, Ill. Contract for the work was let in June by U. S. Engineer Corps to Mississippi Valley Structural Steel Co., Chicago, for $19,976. Lt. Col. Dan I. Sultan is in charge.

Following are unit prices of four main items. Eight bids were submitted, the following prices being those of the low bidder (contract), average of all eight, and the government estimate.

New steel gates, 124,000 lb.: contract, 5.78c.; average, 5.64c.; estimate, 7c. Wheel bearings, upper gates, 48 each: contract, $46.50; average, $59.38; estimate, $45.00. Wheel bearings, lower gates, 48 each: contract, $71.00; average, $96.40; estimate, $88.00. Gate hoist: contract, $3,035; average, $3,810; estimate, $6,200.

Rock Dredging, Passaic River, N. J.

DREDGING OF 26,145 cu.yd. of overburden and 4,50 cu.yd. of rock from the Passaic River, New Jersey, wa placed under contract in June by the U. S. Engineer Office New York. Five bids were received, ranging from $2.0 to $6.91 per cu.yd. for rock excavation and from $2.00 to $2.57 for the overburden. Contract was awarded to P. Sanford Ross, Inc., who bid $2.00 per cu.yd. for both rock and overburden, the contract amount being $61,308. Other bids received are as follows: Trimount Dredging Co., $6.91 for rock and $2.24 for overburden; Bridgeport Dredge & Dock Co., $2.57 for both classes; The Arundel Corp., $2.345 for both classes; Dunbar & Sullivan Dredging Co., $3.32 for both rock and overburden.

Low Paving Price in Ottawa, Canada

ASPHALT paving prices reached the lowest in 25 years with the award of a contract early in August for repaving Somerset St. from Bronson Ave. to Booth St. The contract was awarded to O'Leary, Ltd., for $28,467, an average of $2.32 per sq.yd.

Reinforced-Concrete Weir and Viaduct

BIDS RECEIVED in August from 22 contractors for the construction of a reinforced-concrete weir and concrete deck-girder viaduct on the Sacramento River near Colusa, Calif., ranged from $160,573 to $242,961. Engineer's estimate was $185,408. Contract was let to the low bidder, Fredrickson & Watson, Oakland, by the U. S. Engineer Office, Sacramento. Besides the construction of the weir and viaduct the work involves the sloping of the river bank, removal of an existing levee, building side training dikes, and placing rock revetment on the training dikes and slopes. The weir structure consists of a reinforced-concrete apron 1,650 ft. long, 20 ft. wide and 1 ft. thick; two concrete abutments of the slab slope type, 44x20 ft., 1 ft. thick; cutoff wall 1,734 ft. long of 10-ft. steel sheet piling; open wooden sheet piling wall 1,734 ft. long, 6 ft. deep; cobblestone revetments, with gravel base, both upstream and downstream sides of weir, 1,734 ft. long, 20 to 40 ft. wide, 1.75 to 2.5 ft. thick.

Following are complete unit prices of the three low bidders. (A) Fredrickson & Watson, Oakland, contract; (B) Lord & Bishop and J. R. Reeves, Sacramento; (C) Neves & Harp, Santa Clara.

Item	Quantity	Unit Prices (A)	(B)	(C)
Excavation at weir, cu.yd.	10,000	$0.13	$0.19	$0.19
Excavation, long river, cu.yd.	110,000	.13	.19	.18
Timber test piles, each	6	30.00	58.80	300.00
16-in. sq. reinf. conc. piles, 38 ft. long, lin.ft.	6,900	2.00	2.50	2.00
Steel sheet piling, sq.ft.	17,400	.70	.75	.75
Wood sheet piling, sq.ft.	10,500	.20	.25	.15
Concrete in weir, cu.yd.	1,600	8.50	9.00	10.00
Concrete in viaduct, cu.yd.	2,000	13.00	13.95	13.00
Reinf. in weir, lb.	42,000	.038	.038	.036
Reinf. in viaduct, lb.	530,000	.0375	.036	.036
Structural steel, lb.	35,000	.035	.046	.038
Angle steel, lb.	4,200	.085	.155	.10
Bronze plates, lb.	3,500	.14	.21	.17
Gravel base in revet., cu.yd.	4,300	.50	.80	.95
Cobblestone revet., cu.yd.	13,200	3.80	2.90	3.95
Wood guard rail, 6x6 in., ft.	3,600	.35	.35	.10
Total		$160,573	$165,465	$172,687